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Subject: Revised Testing and Monitoring Options and Costs for Medical Waste Incinerators (MWI's) --Methodology and Assumptions
EPA Contract No. 68-D6-0012; Proposal No. 97-550;
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I. Introduction

Section 129(c) of the Clean Air Act requires the U. S. Environmental Protection Agency (EPA) to include testing and monitoring requirements in regulations developed under section 129. The purpose of these requirements is to allow the EPA to determine whether a source is operating in compliance with the regulations. Cost estimates for a range of monitoring and testing options were presented in a memorandum dated May 20, 1996. However, continuous emission monitoring system (CEMS) vendors expressed concern with the costs developed by EPA for the various CEMS and parameter monitoring systems. In particular, they believe that the costs of CEMS are much lower and the costs of parameter monitoring systems are much higher than those costs estimated by EPA.

These commenters submitted additional information to document the costs for CEMS and parameter monitoring systems. In response to this new information, the EPA has revised its testing and monitoring options and costs. The purpose of this memorandum is to outline these revised testing and monitoring options using revised cost data and assumptions provided by EPA's Emission Measurement Center (EMC).¹ These revised options relate to each of the three emission control options (good combustion, wet scrubbers, and dry scrubbers) initially reviewed in MRI's May 20, 1996 memo, plus an additional emission control option for wet/dry scrubber combinations.²

II. Testing and Monitoring Options

There are four monitoring options presented in this memorandum. These monitoring options range from most to least stringent. For each of these monitoring options, there are two stack emissions testing options. These stack testing options also range from most to least stringent. The two stack testing options are: (1) initial and annual/skip tests and (2) initial tests and incinerator service inspection (no repeat stack tests). A complete listing of the testing and monitoring options is presented in Appendix A at the end of this memorandum.

The most stringent (and most expensive) monitoring option, Monitoring Option 1A, would require a CO CEMS with Appendix F requirements, an HCl CEMS with Appendix F requirements, an opacity monitor without Appendix F requirements, and parameter monitoring for the combustor and, if applicable, for the control device. When Appendix F is required, the CO and HCl CEMS would be used for direct enforcement of the CO and HCl emission limits. The opacity monitor, without Appendix F requirements, would simply provide an indication of opacity and would not be used for direct enforcement of the opacity limit. Stack testing for opacity is included in the testing options under Monitoring Option 1A to compensate for excluding Appendix F requirements. Because the HCl CEMS provides for direct measurement of HCl emissions, Monitoring Option 1A does not require parameter monitoring for HCl for any of the emission control options. For the same reason, stack testing for HCl is also not included as a testing option under Monitoring Option 1A for any of the emission control options.

Monitoring Option 1B is the same as Monitoring Option 1A, except that the HCl CEMS is not required. To compensate for the absence of the HCl CEMS, parameter monitoring for HCl would be added to Monitoring Option 1B for all of the emission control options except good combustion. Stack testing for HCl would also be added to the testing options under Monitoring Option 1B for all emission control options except good combustion.

Monitoring Option 1C is the same as Monitoring Option 1B, except that the opacity monitor is not required. Instead, quarterly EPA Method 9 testing to monitor stack opacity would be added to the testing options included under Monitoring Option 1C to compensate for the absence of the opacity monitor.

Monitoring Option 1D involves the use of portable CO "process" monitors in place of the more expensive CO CEMS. These instruments are far less sensitive than CEMS and, thus, precision and accuracy would be reduced. Under Monitoring Option 1D, detailed quality assurance/quality control (QA/QC) procedures must be prepared and implemented and performance specification tests conducted to ensure that the devices are calibrated properly at all times because measurements would be used for

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direct enforcement of the CO limit. Like Option 1C, the HCl CEMS and opacity monitor are not required with Option 1D.

Monitoring Option 2A is the same as Monitoring Option 1A, except that it would not include Appendix F requirements for the CO and HCl CEMS, which would reduce costs. Without Appendix F requirements, the CO and HCl CEMS and the opacity monitor would simply provide an indication of CO and HCl emissions and opacity and would not be used for direct enforcement of their respective limits. Stack testing for CO and opacity would be added to the testing options under Monitoring Option 2A to compensate for excluding Appendix F requirements from the CO CEMS and opacity monitor. Like Option 1A, no parameter monitoring for HCl is required under Option 2A.

Monitoring Option 2B is the same as Monitoring Option 2A, except that the HCl CEMS is not required. Parameter monitoring for HCl would be added to Option 2B to compensate for the absence of the HCl CEMS.

Monitoring Option 2C is the same as Monitoring Option 2B, except that the opacity monitor is not required. Quarterly EPA Method 9 opacity testing would be added to the testing options under Monitoring Option 2C to compensate for the absence of the opacity monitor.

Monitoring Option 2D also involves the use of portable CO "process" monitors in place of the CO CEMS. Less stringent QA/QC requirements than those for Option 1C are necessary because measurements would not be used for direct enforcement of the CO limit. Like Option 2C, the HCl CEMS and opacity monitor are not required with Option 2D.

Monitoring Option 3 is the same as Monitoring Option 2B, except that, instead of the more expensive CO CEMS, it would require stack testing for CO and more frequent incinerator service inspections under its testing options.

The least stringent (and least expensive) options, Monitoring Options 4A and 4B, would require no CEMS. Instead, they would require quarterly EPA Method 9 testing to monitor stack opacity, stack testing to measure CO and HCl emissions, more frequent incinerator service inspections, and parameter monitoring. The difference between Options 4A and 4B is that Option 4A requires redundant devices for measuring operating parameters for the combustor and, if applicable, the control device plus correlation testing in order to provide continuous compliance with the emission limits, whereas Option 4B requires only single measurement (e.g., using a single thermocouple and a scale) in order to monitor exceedances of operating parameters.

The monitoring options for wet scrubbers and wet/dry scrubber combinations would not include an opacity monitor

because the exhaust from the wet scrubber outlet would have a high moisture content that would interfere with the readings from the opacity monitor. To compensate for the absence of the opacity monitor, quarterly EPA Method 9 opacity testing would be added to testing options under all of the monitoring options for wet scrubbers and wet/dry scrubber combinations.

Tables 1 through 4 present the capital and annual costs for those testing and monitoring options associated with each of the emission control options. The following sections discuss the capital and annual costs for each element of the testing and monitoring costs--CEMS and opacity monitors, process monitors, parameter monitoring, incinerator service inspection, and stack testing (including EPA Method 9 opacity testing and emission testing).

III. CEMS and Opacity Monitors

The most direct means of monitoring compliance with emission limits is the use of CEMS to measure the emissions of each pollutant on a continuous basis. Cost estimates for CO and HCl CEMS and opacity monitors were obtained from EPA/EMC.¹ An O₂ CEMS was also included with the CO CEMS in estimating the costs because an O₂ CEMS would be needed to correct CO measurements to the same basis as the emission limit.

The costs for the CO/O₂ and HCl CEMS are presented both with and without Appendix F requirements. As mentioned in Section II, when Appendix F is required, the CO/O₂ and HCl CEMS would be used for direct enforcement of the CO and HCl emission limits. For those monitoring options without Appendix F requirements, the CO/O₂ and HCl CEMS would simply provide an indication of CO and HCl emissions and would not be used for direct enforcement of their respective limits. The opacity monitor would only be used without Appendix F requirements and would simply provide an indication of opacity and would not be used for direct enforcement of the opacity limit.

A. Capital Costs¹

The capital costs for CO/O₂ and HCl CEMS and opacity monitors are presented in Table 5 and discussed in this section. Capital costs include the purchased equipment cost (PEC) and other ancillary capital costs, such as planning, selecting the type of equipment, providing support facilities, installing and checking the CEMS, performance specification tests (certification), and preparing a QA/QC plan.

The PEC were estimated to be \$20,000 for an opacity monitor, \$69,000 for a CO/O₂ CEMS, and \$61,500 for an HCl CEMS. If an opacity monitor is added to the CO/O₂ CEMS, costs increase by \$20,000, which is the cost of the opacity monitor.

TABLE 1. CAPITAL AND ANNUAL COSTS FOR TESTING AND MONITORING OPTIONS FOR GOOD COMBUSTION CONTROL

	Monitoring Option IA	Monitoring Option IB	Monitoring Option IC	Monitoring Option ID
Parameters	CO2 and HCl CEMS w/ Appendix F Opacity CEMS w/o Appendix F Parameter monitoring for combustor	CO2 CEMS w/ Appendix F Opacity CEMS w/o Appendix F Parameter monitoring for combustor	CO2 CEMS w/ Appendix F Parameter monitoring for combustor	CO2 Process monitor w/ extensive correlation testing
A. Capital Costs, \$				
1. Parameter monitoring (a)	14,682	14,682	14,682	14,682
2. Process monitoring (b)	0	0	0	37,800
3. CEMS (b)				
a. Opacity CEMS (c)	22,400	22,400	22,400	0
b. CO and O2 CEMS	95,800	95,800	95,800	0
c. HCl CEMS	88,300	88,300	0	0
4. EPA Method 9 opacity testing equipment (d)	0	0	600	600
5. Total capital costs	221,182	221,182	132,882	53,082
B. Annual Costs, \$/yr				
1. Parameter monitoring (e)	4,874	4,874	4,874	4,874
2. Process monitoring (b)	0	0	0	23,952
3. Inspector service inspections (e)	0	600	500	500
4. CEMS (b)				
a. Opacity CEMS (c)	6,027	6,027	0	0
b. CO and O2 CEMS	35,485	35,485	35,485	0
c. HCl CEMS	34,304	34,304	0	0
5. Stack testing				
a. Stack emission test (f)	12,400	1,900	12,400	12,400
b. In-house EPA Method 9 opacity testing				
i. Operating labor (g)	0	0	0	528
ii. Registration/certification (h)	0	0	0	600
iii. Travel (i)	0	0	0	40
iv. Overhead (j)	0	0	0	29
v. Taxes, insur., and admin. (k)	0	0	0	24
vi. Capital recovery (l)	0	0	158	158
6. Total annual cost	93,089	83,089	68,786	42,605
				32,605

(a) See Table 6 for details.

(b) See Table 5 for details.

(c) Costs for opacity with other CEMS lower due to economies of scale.

(d) Abey level, high quality compass, range finder, dividers, and stopwatch.

(e) Testing Option B costs include cost of ins�erator service inspection (annual-\$500; quarterly-\$2,000) when no CO2O2 monitoring system.

(f) Test costs = \$8,000 for PM test; \$21,000 for CDDCDF test; \$5,000 for CO test; and \$1,000 for metals test (based on EPA cost estimates).

(g) For skip testing assume 6 sets of tests over a 20-year period.

(h) For registration/certification assume 5 days, 8 hr/d, and \$12/hr.

(i) Assume \$300 assas and cassette.

(j) Assume 100 mpp, 2 ipsy, and \$0.20/m.

(k) Taxes, insurance, and admin. = 4 percent of the capital cost (or EPA Method 9 opacity test cost or EPA Method 9 opacity testing system). The capital recovery factor is based on a 6-year equipment life and a 10 percent interest rate.

(l) Capital recovery = capital recovery factor (0.28360) x capital cost (or EPA Method 9 opacity test cost).

TABLE 1. (continued)

Parameters	Monitoring Option 2A		Monitoring Option 2B		Monitoring Option 2C		Monitoring Option 2D	
	CO ₂ and HCl CEMS w/o Appendix F Opacity CEMS w/o Appendix F Parameter monitoring for combustor Testing Option A	CO ₂ CEMS w/o Appendix F Opacity CEMS w/o Appendix F Parameter monitoring for combustor Testing Option B	CO ₂ CEMS w/o Appendix F Parameter monitoring for combustor Testing Option A	CO ₂ CEMS w/o Appendix F Parameter monitoring for combustor Testing Option B	Testing Option A	Testing Option B	CO ₂ Process monitor w/o exhaustive correlation testing Parameter monitoring for combustor Testing Option A	CO ₂ Process monitor w/o exhaustive correlation testing Parameter monitoring for combustor Testing Option B
A. Capital Costs, \$								
1. Parameter monitoring (a)	14,682	14,682	14,682	14,682	14,682	14,682	14,682	14,682
2. Process monitoring (b)	0	0	0	0	0	0	31,800	31,800
3. CEMS (b)								
a. Opacity CEMS (c)	21,500	24,500	24,500	24,500	0	0	0	0
b. CO and O ₂ CEMS	93,300	93,300	93,300	93,300	0	0	0	0
c. HCl CEMS	85,800	85,800	0	0	0	0	0	0
4. EPA Method 9 opacity testing equipment (d)	0	0	0	0	600	600	600	600
5. Total capital cost:	218,282	218,282	132,482	132,482	108,582	108,582	47,082	47,082
B. Annual Costs, \$/yr								
1. Parameter monitoring (a)	4,674	4,674	4,674	4,674	4,674	4,674	4,674	4,674
2. Process monitoring (b)	0	0	0	0	0	0	8,007	8,007
3. Incinerator service inspections (e)	0	500	0	500	0	500	0	500
4. CEMS (b)								
a. Opacity CEMS (c)	7,858	7,858	7,858	7,858	0	0	0	0
b. CO and O ₂ CEMS	22,691	22,691	22,691	22,691	0	0	0	0
c. HCl CEMS	21,510	21,510	0	0	0	0	0	0
5. Stack testing								
a. Stack emission test (f)	14,000	2,100	14,000	2,100	14,000	2,100	14,000	2,100
b. In-house EPA Method 9 opacity testing	0	0	0	0	528	528	600	528
i. Operating labor (g)	0	0	0	0	600	600	40	600
ii. Registration/Certification (h)	0	0	0	0	40	40	40	40
iii. Travel (i)	0	0	0	0	29	29	29	29
iv. Overhead (j)	0	0	0	0	24	24	24	24
v. Taxes, insur., and admin. (k)	0	0	0	0	158	158	158	158
vi. Capital recovery (l)	0	0	0	0	31,544	31,544	28,260	28,260
6. Total annual cost:	70,933	59,533	49,423	38,023	42,944	31,544	16,860	16,860

(a) See Table 6 for details.

(b) See Table 5 for details.

(c) Costs for opacity with other CEMS lower due to economies of scale.

(d) Abbrev. level high quality compass, range finder, binoculars, and stopwatch.

(e) Test Option B costs include cost of incinerator service inspection (annual—\$500; quarterly—\$2,000) when no CO₂ monitoring system.(f) Test costs = \$8,000 for PM test, \$21,000 for CO₂ test, \$5,000 for HCl test, \$6,000 for metals test, \$1,000 for opacity test (based on EPA cost estimates).

(g) Assume 100 min/Op, 2 trips/yr, and 50 20hr.

(h) Overhead = 60 percent of labor for quarterly EPA Method 9 opacity readings (based on standard QA/QPS cost procedures).

(i) Taxes, insurance, and admin. = 4 percent of the capital cost for EPA Method 9 opacity testing system (based on standard QA/QPS cost procedures).

(j) Capital recovery = capital recovery factor (0.03360) x capital cost for EPA Method 9 opacity testing system. The capital recovery factor is based on a 6-year equipment life and a 10 percent interest rate.

TABLE 1. (continued)

Parameters	Monitoring Option A		Monitoring Option B		Monitoring Option C	
	Testing Option A Initial test for PM, CO, CDD/CDf-Hg, opacity, annual/ skip test for PM, CO, CDD/CDf, opacity	Testing Option B Initial test for PM, CO, CDD/CDf-Hg, opacity	Testing Option A Initial test for PM, CO, CDD/CDf-Hg, opacity, annual/ skip test for PM, CO, opacity test for opacity	Testing Option B Initial test for PM, CO, CDD/CDf-Hg, opacity, annual/ skip test for PM, CO, opacity test for opacity	Testing Option A Initial test for PM, CO, CDD/CDf-Hg, opacity, annual/ skip test for PM, CO, opacity test for opacity	Testing Option B Initial test for PM, CO, CDD/CDf-Hg, opacity, annual/ skip test for PM, CO, opacity test for opacity
A. Capital Costs, \$						
1. Parameter monitoring (a)	14,682	14,682	35,258	35,258	14,682	14,682
2. Process monitoring (b)	0	0	0	0	0	0
3. CEMS (b)	29,200	29,200	0	0	0	0
a. Opacity CEMS (c)	0	0	0	0	0	0
b. CO and O ₂ CEMS	0	0	0	0	0	0
c. HCl CEMS	0	0	0	0	0	0
4. EPA Method 9 opacity testing equipment (d)	0	0	800	800	600	600
5. Total capital cost	43,882	43,882	35,858	35,858	15,282	15,282
B. Annual Costs, \$/yr						
1. Parameter monitoring (a)	4,874	4,874	27,852	27,852	4,874	4,874
2. Process monitoring (b)	0	0	0	0	0	0
3. Inspector service inspections (e)	0	2,000	0	2,000	0	2,000
4. CEMS (b)	10,598	10,598	0	0	0	0
a. Opacity CEMS (c)	0	0	0	0	0	0
b. CO and O ₂ CEMS	0	0	0	0	0	0
c. HCl CEMS	0	0	0	0	0	0
5. Stack testing						
a. Stack emission test (f)	14,000	2,100	6,300	2,100	6,300	2,100
i. In-house EPA Method 9 opacity testing	0	0	528	528	528	528
ii. Operating labor (g)	0	0	600	40	600	600
iii. Regulator certification (h)	0	0	40	40	40	40
iv. Travel (i)	0	0	29	29	29	29
v. Overhead (j)	0	0	24	24	24	24
vi. Taxes, insur., and admin. (k)	0	0	158	158	158	158
vii. Capital recovery (l)	0	0	33,331	33,331	12,553	10,353
6. Total annual cost	29,472	19,572	35,531	35,531		

(a) See Table 6 for details.

(b) See Table 5 for details.

(c) Costs for opacity with other CEMS lower due to economies of scale.

(d) Abbrev. level high quality compressor, range finder, binoculars, and stopwatch.

(e) Testing Option B costs include cost of technician for service inspection (annual—\$500; quarterly—\$2,000) when no CO/CO₂ monitoring system.

(f) Test costs = \$8,000 for PM test, \$21,000 for CDD/CDf test, \$5,000 for HCl test, \$8,000 for metals test \$4,000 for HCl test, and \$1,000 for opacity test (based on standard OAQPS cost procedures).

(g) For stack testing, assume 8 sets of tests over a 20-year period.

(h) Assume \$100/m³/ip, 2 trips/hr, and \$12/hr.

(i) Overhead = 80 percent of labor for quarterly EPA Method 9 opacity testing system (based on standard OAQPS cost procedures).

(j) Taxes, insurance, and admin. = 4 percent of the capital cost for EPA Method 9 opacity testing system. The capital recovery factor is based on a 5-year equipment life and a 10 percent interest rate.

(k) Capital recovery = capital recovery factor (0.28380) x capital cost (based on a 5-year equipment life and a 10 percent interest rate).

(l) Capital recovery = capital cost (based on a 5-year equipment life and a 10 percent interest rate).

TABLE 2. CAPITAL AND ANNUAL COSTS FOR TESTING AND MONITORING OPTIONS FOR WET SCRUBBERS

	Monitoring Option A CO/CO ₂ and HCl CEMS w/ Appendix F Parameter monitoring for combustor & wet scrubber	Monitoring Option B CO/CO ₂ CEMS w/ Appendix F Parameter monitoring for combustor & wet scrubber	Monitoring Option C CO/CO ₂ CEMS w/ Appendix F Parameter monitoring for combustor & wet scrubber	Monitoring Option D CO/CO ₂ Process monitor w/ extensive correlation testing Parameter monitoring for combustor & wet scrubber
Parameters	Testing Option A Initial and annual/ skip test for PM, CDDICDF, Pb, Cd,Hg, opacity, qtrly test for opacity	Testing Option B Annual Inspec.; Initial test for PM, CDDICDF, Pb,Cd,Hg, opacity; qtrly test for opacity	Testing Option A Initial and annual/ skip test for PM, CDDICDF, HCl, Pb,Cd,Hg, opacity; qtrly test for opacity	Testing Option A Initial and annual/ skip test for PM, CDDICDF, HCl, Pb,Cd,Hg, opacity; qtrly test for opacity
A. Capital Costs, \$				
1. Parameter monitoring (a)	15,346	15,546	18,766	18,786
2. Process monitoring (b)	0	0	0	37,800
3. CEMS (b)	95,400	95,800	95,800	0
a. CO and O ₂ CEMS	88,300	88,300	0	0
b. HCl CEMS	600	600	600	600
4. EPA Method 9 opacity testing equipment (c)	600	600	600	600
5. Total capital cost	200,246	200,246	115,186	57,186
B. Annual Costs, \$/yr				
1. Parameter monitoring (a)	6,038	5,038	6,851	5,651
2. Process monitoring (b)	0	0	0	23,952
3. Incinerator service inspection (d)	0	600	500	500
4. CEMS (b)	35,485	35,485	34,485	0
a. CO and O ₂ CEMS	34,304	34,304	0	0
b. HCl CEMS	15,200	1,900	17,200	2,150
5. Slack testing				17,200
a. Slack emission test (e)				2,150
b. In-house EPA Method 9 opacity testing				528
i. Operating labor (f)	528	528	528	528
ii. Registration/certification (g)	600	600	600	600
iii. Travel (h)	40	40	40	40
iv. Overhead (i)	29	29	29	29
v. Taxes, insur., and admin. (j)	24	24	24	24
vi. Capital recovery (k)	158	158	158	158
4. Total annual cost	91,405	78,605	59,715	48,183
				33,633

(a) See Table 6 for details. Parameter monitoring costs do not include pH meter in those cases where there is an HCl CEMS.

(b) See Table 5 for details.

(c) Abney level, high quality compass, range finds, binoculars, and stopwatch.

(d) Testing Option B costs include cost of incinerator service inspection (annual-\$500; quarterly-\$2,000) when no CO/CO₂ monitoring system.

(e) Test costs = \$8,000 for PM test, \$21,000 for CDDICDF test, \$5,000 for CO test, and \$1,000 for opacity test (based on EPA cost estimates).

(f) For skip testing, assume 8 sets of tests over a 20-year period.

(g) For registration/certification, assume 5 dly, 8 hr/d, and \$12/hr.

(h) Assume 530/Class and 2 classes.

(i) Assume 100 min/d, 2 trips/mi, and \$0.20/mi.

(j) Capital recovery = capital recovery factor (0.26380) x capital cost for EPA Method 9 opacity testing system. The capital recovery factor is based on a 5-year equipment life and a 10 percent interest rate.

(k) Capital recovery = capital recovery factor (0.26380) x capital cost for standard OAQPS cost procedures).

TABLE 2. (continued)

		Monitoring Option 2A		Monitoring Option 2B		Monitoring Option 2C		Monitoring Option 2D	
		CO ₂ and HCl CEMS two Appendix F Parameter monitoring for combustor & wet scrubber		CO ₂ CEMS two Appendix F Parameter monitoring for combustor & wet scrubber		Parameter monitoring for combustor & wet scrubber		CO ₂ Process monitor w/o extensive correlation testing for combustor & wet scrubber	
		Testing Option A	Testing Option B						
Parameters		Initial and annual/ skip test for PM, CO, CDDICDF, HCl, Pb, Cd, Hg, opacity, quaty test for opacity	Annual Inspect: Initial test for PM, CO, CDDICDF, HCl, Pb, Cd, Hg, opacity, quaty test for opacity	Initial and annual/ skip test for PM, CO, CDDICDF, HCl, Pb, Cd, Hg, opacity, quaty test for opacity	Annual Inspect: Initial test for PM, CO, CDDICDF, HCl, Pb, Cd, Hg, opacity, quaty test for opacity	Initial and annual/ skip test for PM, CO, CDDICDF, HCl, Pb, Cd, Hg, opacity, quaty test for opacity	Annual Inspect: Initial test for PM, CO, CDDICDF, HCl, Pb, Cd, Hg, opacity, quaty test for opacity	Initial and annual/ skip test for PM, CO, CDDICDF, HCl, Pb, Cd, Hg, opacity, quaty test for opacity	Annual Inspect: Initial test for PM, CO, CDDICDF, HCl, Pb, Cd, Hg, opacity, quaty test for opacity
A. Capital Costs, \$									
1. Parameter monitoring (a)		15,546	15,546	16,766	18,766			18,766	18,766
2. Process monitoring (b)		0	0	0	0			31,800	31,800
3. CEMS (b)									
a. CO and O ₂ CEMS		93,300	93,300	93,300	93,300			0	0
b. HCl CEMS		85,800	85,800	0	0			0	0
4. EPA Method 9 opacity testing equipment (c)		600	600	600	600			600	600
5. Total capital cost		195,246	195,246	112,586	112,586			51,186	51,186
B. Annual Costs, \$/yr									
1. Parameter monitoring (a)		6,038	6,038	5,551	5,651				
2. Process monitoring (b)		0	0	0	0			5,651	5,651
3. Incinerator service inspection (d)		0	500	0	500			8,007	8,007
4. CEMS (b)								0	500
a. CO and O ₂ CEMS		22,691	22,691	22,591	22,591				
b. HCl CEMS		21,510	21,510	0	0			0	0
5. Stack testing									
a. Stack emission test (e)		16,800	2,350	16,800	2,350			18,800	2,350
b. In-house EPA Method 9 opacity testing									
I. Operating labor (f)		528	528	528	528			528	528
II. Registration/certification (g)		600	600	600	600			600	600
III. Travel (h)		40	40	40	40			40	40
N. Overhead (i)		29	29	29	29			29	29
V. Taxes, insur., and admin. (j)		24	24	24	24			24	24
VI. Capital recovery (k)		158	158	158	158			158	158
4. Total annual cost		69,418	53,460	48,522	32,572			33,838	17,888

(a) See Table 6 for details. Parameter monitoring costs do not include pH meter in those cases where there is an HCl CEMS.

(b) See Table 5 for details.

(c) Abbrey level, high quality compass, range finder, binoculars, and stopwatch.

(d) Test costs = \$8,000 for PM test, \$21,000 for CDDICDF test, \$5,000 for CO test, and \$1,000 for opacity test (based on EPA cost estimates).

(e) For skip testing, assume sets of tests over a 20-year period.

(f) For registration/certification, assume 5 day, 8 hr/d, and \$172/hr. For quarterly EPA Method 9 opacity reading, assume 1 hr/reading, 1 reading/quarter, 4 quarters/yr, and \$12/hr.

(g) Assume 100 m³/hp, 2 trips/day, and \$20/ml.

(h) Assume \$300/class and 2 classes/yr.

(i) Overhead = 50 percent of labor for quarterly EPA Method 9 opacity reading (based on standard OACPS cost procedures).

(j) Capital recovery capital recovery factor (0.26380) x capital cost for EPA Method 9 opacity testing system. The capital recovery factor is based on a 5-year equipment life and a 10 percent interest rate.

(k) Taxes, insurance, and admin. = 1 percent of the capital cost for EPA Method 9 opacity testing system. The capital recovery factor is based on a 5-year equipment life and a 10 percent interest rate.

TABLE 2. (continued)

	Monitoring Option 3 Single measurement parameter monitoring for combustor & wet scrubber		Monitoring Option 4A Redundant measurement parameter monitoring for combustor & wet scrubber		Monitoring Option 4B Single measurement parameter monitoring for combustor & wet scrubber	
Parameters	Testing Option A	Testing Option B	Testing Option A	Testing Option B	Testing Option A	Testing Option B
Initial and annual/ skip test for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, opacity, quity test for opacity	Quatty inspect.; Initial test for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, opacity, quity test for opacity	Quatty inspect.; Initial test for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, opacity, annual/ skip test for PM, CO, HCl; quity test for opacity	Initial test for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, opacity, annual/ skip test for PM, CO, HCl; quity test for opacity	Initial test for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, opacity, annual/ skip test for PM, CO, HCl; quity test for opacity	Initial test for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, opacity, annual/ skip test for PM, CO, HCl; quity test for opacity	Initial test for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, opacity, annual/ skip test for PM, CO, HCl; quity test for opacity
A. Capital Costs, \$						
1. Parameter monitoring (a)	16,786	16,786	40,183	40,183	16,786	16,786
2. Process monitoring (b)	0	0	0	0	0	0
3. CEMS (b)	0	0	0	0	0	0
a. CO and O ₂ CEMS	0	0	0	0	0	0
b. HCl CEMS	0	0	0	0	0	0
4. EPA Method 9 opacity testing equipment (c)	600	600	600	600	600	600
5. Total capital cost	19,386	19,386	40,783	40,783	19,386	19,386
B. Annual Costs, \$/yr						
1. Parameter monitoring (a)	5,651	5,651	26,627	26,627	5,651	5,651
2. Process monitoring (b)	0	0	0	0	0	0
3. Incinerator service inspection (d)	0	2,000	0	2,000	0	2,000
4. CEMS (b)	0	0	0	0	0	0
a. CO and O ₂ CEMS	0	0	0	0	0	0
b. HCl CEMS	0	0	0	0	0	0
5. Stack testing						
a. Stack emission test (e)	16,800	2,350	0	2,350	0	2,350
b. In-house EPA Method 9 opacity testing	528	528	528	528	528	528
i. Operating labor (f)	600	600	600	600	600	600
ii. Registration/certification (g)	40	40	40	40	40	40
iii. Travel (h)	29	29	29	29	29	29
iv. Overhead (i)	24	24	24	24	24	24
v. Taxes, insur., and admin. (j)	158	158	158	158	158	158
vi. Capital recovery (k)						
4. Total annual cost	25,831	11,381	38,306	34,356	15,331	11,381

(a) See Table 6 for details. Parameter monitoring costs do not include pH meter in those cases where there is an HCl CEMS.

(b) See Table 5 for details.

(c) Abbey level, high quality compass, range finder, binoculars, and stopwatch.

(d) Testing Option B costs include cost of incinerator service inspection (annual-\$500; quarterly-\$2,000) when no CO/CO₂ monitoring system.

(e) Test costs = \$8,000 for PM test, \$21,000 for CDD/CDF test, \$5,000 for HCl test, \$8,000 for metals test, \$4,000 for CO test, and \$1,000 for opacity test (based on EPA cost estimates).

(f) For trip testing, assume 8 sets of tests over a 20-year period.

(g) For registration/certification, assume 5 dyr, 8 hr/d, and \$12/hr.

(h) Assume 100 mi/trip, 2 trips/yr, and \$0.20/ml.

(i) Assume \$300/yr and 2 classes/yr.

(j) Overhead = 60 percent of labor for quarterly EPA Method 9 opacity readings (based on standard OAQPS cost procedures).

(k) Taxes, insurance, and admin. = 4 percent of the capital cost for EPA Method 9 opacity testing system. The capital recovery factor is based on a 5-year equipment life and a 10 percent interest rate.

(l) Capital recovery = capital recovery factor (0.26380) x capital cost for EPA Method 9 opacity testing system.

TABLE 3 . CAPITAL AND ANNUAL COSTS FOR TESTING AND MONITORING OPTIONS FOR DRY SCRUBBERS

Parameters	Monitoring Option 1A		Monitoring Option 1B		Monitoring Option 1C		Monitoring Option 1D	
	CO ₂ and HCl CEMS w/ Appendix F Opacity CEMS w/o Appendix F Parameter monitoring for combustor & dry scrubber	CO ₂ CEMS w/ Appendix F Opacity CEMS w/o Appendix F Parameter monitoring for combustor A & dry scrubber	CO ₂ CEMS w/ Appendix F Opacity CEMS w/o Appendix F Parameter monitoring for combustor A & dry scrubber	CO ₂ CEMS w/ Appendix F Opacity CEMS w/o Appendix F Parameter monitoring for combustor A & dry scrubber	CO ₂ Process monitor w/o extensive correlation testing Parameter monitoring for combustor & dry scrubber	CO ₂ Process monitor w/o extensive correlation testing Parameter monitoring for combustor & dry scrubber	CO ₂ Process monitor w/o extensive correlation testing Parameter monitoring for combustor & dry scrubber	CO ₂ Process monitor w/o extensive correlation testing Parameter monitoring for combustor & dry scrubber
A. Capital Costs, \$								
1. Parameter monitoring (a)	14,790	14,790	14,790	14,790	14,790	14,790	14,790	14,790
2. Process monitoring (b)	0	0	0	0	0	0	37,800	37,800
3. CEMS (b)	22,400	22,400	22,400	22,400	95,800	95,800	0	0
a. Opacity CEMS (c)	95,800	95,800	95,800	95,800	0	0	0	0
b. CO and O ₂ CEMS	88,300	88,300	88,300	88,300	0	0	0	0
c. HCl CEMS	0	0	0	0	0	0	600	600
4. EPA Method 9 opacity testing equipment (d)	0	221,290	221,290	132,990	132,990	111,190	53,190	53,190
5. Total capital cost								
B. Annual Costs, \$/yr								
1. Parameter monitoring (a)	5,918	5,918	6,942	6,942	0	0	23,952	23,952
2. Process monitoring (b)	0	0	0	0	500	500	0	500
3. Inspector service inspections (e)	0	500	0	0	0	0	0	0
4. CEMS (b)	0,027	6,027	6,027	6,027	35,485	35,485	0	0
a. Opacity CEMS (c)	35,485	35,485	35,485	35,485	0	0	0	0
b. CO and O ₂ CEMS	34,304	34,304	34,304	34,304	0	0	0	0
5. Stack testing								
a. Stack emission test (f)	15,200	1,900	17,200	2,150	17,200	2,150	17,200	17,200
b. In-house EPA Method 9 opacity testing	0	0	0	0	0	0	528	528
I. Operating labor (g)	0	0	0	0	0	0	600	600
II. Registration/certification (h)	0	0	0	0	0	0	40	40
III. Travel (i)	0	0	0	0	0	0	29	29
IV. Overhead (j)	0	0	0	0	0	0	24	24
V. Taxes, insur., and admin. (k)	0	0	0	0	0	0	158	158
VI. Capital recovery (l)	0	0	0	0	0	0	0	0
4. Total annual cost	96,934	84,134	65,654	51,104	61,006	46,456	49,473	34,923

(a) See Table 6 for details. Parameter monitoring costs do not include line monitoring in those cases where there is an HCl CEMS.

(b) See Table 5 for details.

(c) Costs for opacity with other CEMS lower due to economies of scale.

(d) Abbrev level, range, quality, compass, range finder, binoculars, and stopwatch.

(e) Testing Option B costs include cost of in-rector service inspection (annual-\$500; quarterly-\$2,000) when no CO/CO₂ monitoring system.

(f) Test costs = \$8,000 for PM test, \$21,000 for CDDCDF test, \$5,000 for HCl test, \$6,000 for metal test, \$4,000 for CO test, and \$1,000 for EPA cost estimates).

(g) For skip testing, assume sets of tests over a 20-year period.

(h) For registration/certification, assume 5 days, \$170, and \$12/hr.

(i) Assume \$300/class and 2 classes/year.

(j) Assume 100 m/hr, \$2/hr/hr, and \$0.20/m³.

(k) Taxes, insurance, and admin. = 4 percent of the capital cost for EPA Method 9 opacity testing system (based on standard OAQPS cost procedures).

(l) Capital recovery = capital / recovery factor (0.26380) × capital cost for EPA Method 9 opacity testing system. The capital recovery factor is based on a 6-year equipment life and a 10 percent interest rate.

TABLE 3. (continued)

	Monitoring Option 2A		Monitoring Option 2B		CO202 CEMS w/o Appendix F		CO202 CEMS w/o Appendix F		Monitoring Option 2C	
	Testing Option A	Testing Option B	Testing Option A	Testing Option B	Parameter monitoring for combustor & dry scrubber	Parameter monitoring for combustor & dry scrubber	Aerial Inspect.; initial and annual spot test for PM, CO, CDDICDF, HCl, Pb, Cd, Hg, opacity	Aerial Inspect.; initial and annual spot test for PM, CO, CDDICDF, HCl, Pb, Cd, Hg, opacity	Initial and annual spot test for PM, CO, CDDICDF, HCl, Pb, Cd, Hg, opacity, grainy test for opacity	Initial and annual spot test for PM, CO, CDDICDF, HCl, Pb, Cd, Hg, opacity, grainy test for opacity
Parameters										
A. Capital Costs, \$										
1. Parameter monitoring (e)	14,790	14,790	14,790	14,790	0	0	14,790	14,790	0	14,790
2. Process monitoring (b)	0	0	0	0	0	0	0	0	0	31,800
3. CEMS (b)										
a. Opacity CEMS (c)	24,500	24,500	24,500	24,500	93,300	93,300	93,300	93,300	0	0
b. CO and O2 CEMS	93,300	93,300	85,800	85,800	0	0	0	0	0	0
c. HCl CEMS	85,800	85,800	0	0	0	0	0	0	0	0
4. EPA Method 9 opacity testing equipment (d)	0	0	0	0	0	0	600	600	600	600
5. Total capital cost	218,390	218,390	218,390	218,390	132,590	132,590	108,690	108,690	47,190	47,190
B. Annual Costs, \$/yr										
1. Parameter monitoring (e)	5,918	5,918	6,942	6,942	0	0	0	0	0	6,942
2. Process monitoring (b)	0	0	0	0	0	0	0	0	0	0
3. Incinerator service inspections (e)	0	500	0	0	600	0	500	500	0	500
4. CEMS (b)										
a. Opacity CEMS (c)	7,656	7,656	7,656	7,656	22,691	22,691	22,691	22,691	0	0
b. CO and O2 CEMS	22,691	22,691	21,310	21,310	0	0	0	0	0	0
c. HCl CEMS	21,310	21,310	0	0	0	0	0	0	0	0
5. Stack testing										
a. In-house EPA Method 9 opacity testing	18,800	2,350	18,800	2,350	0	0	0	0	0	0
i. Operating labor (g)	0	0	0	0	0	0	0	0	0	0
ii. Registration/certification (h)	0	0	0	0	0	0	0	0	0	0
iii. Travel (i)	0	0	0	0	0	0	40	40	40	40
iv. Overhead (j)	0	0	0	0	0	0	29	29	29	29
v. Taxes, insur., and admin. (k)	0	0	0	0	0	0	24	24	24	24
vi. Capital recovery (l)	0	0	0	0	0	0	158	158	158	158
4. Total annual cost	76,777	60,427	56,291	40,341	49,812	33,662	35,129	35,129	19,179	19,179

(a) See Table 6 for details. Parameter monitoring costs do not include line monitoring in those cases where there is an HCl CEMS.

(b) See Table 5 for details.

(c) Costs for opacity with other CEMS lower due to economies of scale.

(d) Average level high quality compass range filter, binoculars, and stopwatch.

(e) Testing Option B costs include cost of incinerator service inspection (annual-\$500; quarterly-\$2,000) when no CO202 monitoring system.

(f) Test costs = \$8,000 for PM test, \$2,000 for CDDICDF test, \$5,000 for HCl test, \$8,000 for metals test, \$1,000 for opacity test (based on EPA cost estimates).

(g) For stack testing, assume 8 sets of tests over a 20-year period.

(h) Assume 100 m/hr/hr, 2 flps/hr, and \$0.20/m³.

(i) Overhead = 60 percent of labor (or quarterly EPA Method 9 opacity readings based on standard QA/QPS cost procedures).

(j) Taxes, insurance, and admin = 4 percent of the capital cost.

(k) Capital recovery = capital cost for EPA Method 9 opacity testing system. The capital recovery factor is based on a 5-year equipment life and a 10 percent interest rate.

(l) Capital recovery = capital cost for EPA Method 9 opacity testing system. The capital recovery factor is based on a 5-year equipment life and a 10 percent interest rate.

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TABLE 3. (continued)

	Monitoring Option A		Monitoring Option B		Single measurement parameter monitoring for combustor & dry scrubber
	Opacity CEMS w/o Appendix F Parameter monitoring for combustor & dry scrubber	Redundant measurement parameter monitoring for combustor & dry scrubber	Testing Option A	Testing Option B	
Parameters	Initial and annual/ skip test for PM, CO, CDD/CDIF, HCl/Pb/Cd/Hg, opacity	Offsite Inspect: Initial test for PM, CO, CDD/CDIF, HCl/Pb/Cd/Hg, opacity	Initial test for PM, CO/CDD/CDIF, HCl/Pb/Cd/Hg, opacity; annual/ skip test for PM, CO/HCl; opacity test for opacity	Offsite Inspect: Initial test for PM, CO/CDD/CDIF, HCl/Pb/Cd/Hg, opacity; annual/ skip test for PM, CO/HCl; opacity test for opacity	Offsite Inspect: Initial test for PM, CO/CDD/CDIF, HCl/Pb/Cd/Hg, opacity; annual/ skip test for PM, CO/HCl; opacity test for opacity
A. Capital Costs, \$					
1. Parameter monitoring (a)	14,790	14,790	35,388	35,388	14,790
2. Process monitoring (b)	0	0	0	0	0
3. CEMS (b)	29,200	29,200	0	0	0
a. Opacity CEMS (c)	0	0	0	0	0
b. CO and O ₂ CEMS	0	0	0	0	0
c. HCl CEMS	0	0	0	0	0
4. EPA Method 9 opacity testing equipment (d)	0	0	600	600	600
5. Total capital cost	43,990	43,990	35,988	35,988	15,390
B. Annual Costs, \$/yr					
1. Parameter monitoring (a)	6,942	6,942	21,872	21,872	6,942
2. Process monitoring (b)	0	0	0	0	0
3. Incubator service inspections (e)	0	2,000	0	2,000	0
4. CEMS (b)	10,598	10,598	0	0	2,000
a. Opacity CEMS (c)	0	0	0	0	0
b. CO and O ₂ CEMS	0	0	0	0	0
c. HCl CEMS	0	0	0	0	0
5. Stack testing	18,800	2,350	8,300	2,350	8,300
a. Stack emission test (f)	0	0	628	628	2,350
i. Operating labor (g)	0	0	600	600	528
ii. Registration/Certification (h)	0	0	40	40	600
iii. Travel (i)	0	0	29	29	40
iv. Overhead (j)	0	0	24	24	29
v. Taxes, insur., and admin. (k)	0	0	158	158	24
vi. Capital recovery (l)	0	0	0	0	158
b. Total annual cost	36,340	21,890	37,551	33,801	16,621
					12,671

(a) See Table 6 for details. Parameter monitoring costs do not include line monitoring in those cases where there is an HCl CEMS.

(b) See Table 5 for details.

(c) Costs for opacity with other CEMS lower due to economies of scale.

(d) Abney level, high quality compass, range finder, binoculars, and stopwatch.

(e) Testing Option B costs include cost of incubator, service inspection (annual-\$500; quarterly-\$2,000) when no CO/CO₂ monitoring system.

(f) Test costs = \$8,000 for PM test, \$21,000 for CDD/CDIF test, \$5,000 for HCl test, \$8,000 for metals test, \$14,000 for opacity test (based on EPA cost estimates).

(g) For skip testing, assume 8 sets of tests over a 20-year period.

(h) For registration/certification, assume 5 dir., 6 hr/d, and \$12/hr.

(i) Assume 300 miles and 2 classes.

(j) Assume 100 mph, 2 trips/yr, and \$0.20/mi.

(k) Overhead = 60 percent of labor for quarterly EPA Method 9 opacity readings (based on standard OA/GPS cost procedure).

(l) Taxes, insurance, and admin. = 4 percent of the capital cost for EPA Method 9 opacity testing system (based on standard OA/GPS cost procedure).

(m) Capital recovery = capital (recovery) factor (0.2530) x capital cost for EPA Method 9 opacity testing system. The capital recovery factor is based on a 5-year equipment life and a 10 percent interest rate.

TABLE 4. CAPITAL AND ANNUAL COSTS FOR TESTING AND MONITORING OPTIONS FOR WET/DRY SCRUBBER COMBINATIONS

	Monitoring Option 1A	Monitoring Option 1B	Monitoring Option 1C	Monitoring Option 1D
Parameters	CO/CO ₂ and HCl CEMS w/ Appendix F Parameter monitoring for combustor & wet/dry scrubber	CO/CO ₂ CEMS w/ Appendix F Parameter monitoring for combustor & wet/dry scrubber	CO/CO ₂ CEMS w/ Appendix F Parameter monitoring for combustor & wet/dry scrubber	CO/CO ₂ Process monitor w/ extensive correlation testing for combustor & Parameter monitoring for combustor & wet/dry scrubber
A. Capital Costs, \$				
1. Parameter monitoring (a)	15,634	15,654	18,894	18,894
2. Process monitoring (b)	0	0	0	37,800
3. CEMS (b)	95,800	95,800	95,800	0
a. CO and O ₂ CEMS	88,300	88,300	0	0
b. HCl CEMS	600	600	600	0
4. EPA Method 9 opacity testing equipment (c)	200,354	200,354	115,294	600
5. Total capital cost				57,294
B. Annual Costs, \$/yr				
1. Parameter monitoring (a)	6,082	6,082	7,720	7,720
2. Process monitoring (b)	0	0	0	23,952
3. Incinerator service inspection (d)	0	500	500	500
4. CEMS (b)	35,485	35,485	35,485	0
a. CO and O ₂ CEMS	34,304	34,304	0	0
b. HCl CEMS	152	152	152	0
5. Stack testing				
a. Stack emission test (e)				
b. In-House EPA Method 9 opacity testing	15,200	1,900	17,200	17,200
i. Operating labor (f)	528	528	528	528
ii. Registration/certification (g)	600	600	600	600
iii. Travel (h)	40	40	40	40
iv. Overhead (i)	29	29	29	29
v. Taxes, Insur., and admin. (j)	24	24	24	24
vi. Capital recovery (k)	158	158	158	158
4. Total annual cost	92,450	78,650	61,764	47,234
				50,251
				35,701

(a) See Table 6 for details. Parameter monitoring costs do not include pH meter or lime monitoring in those cases where there is an HCl CEMS.

(b) See Table 5 for details.

(c) Abbrev level, high quality compass, range finder, binoculars, and stopwatch.

(d) Testing Option B costs include cost of achieving service inspection (annual-\$6000, quarterly-\$2,000) when no CO/CO₂ monitoring system.

(e) Test costs = \$8,000 for PM test, \$2,000 for COD/CDF test, \$5,000 for CO test, and \$1,000 for metals test. For skip testing, assume 8 sets of tests over a 20-year period.

(f) For skip testing, assume 5 d/yr, 8 hr/d, and \$12/hr. For quarterly EPA Method 9 opacity readings, assume 1 hr/reading, 1 reading/quarter, 4 quarters/yr, and \$12/hr.

(g) Assume \$100/class and 2 classes/yr.

(h) Assume 100 mi/hip, 2 trips/yr, and 10/20 mi/lt.

(i) Taxes, insurance, and admin = 4 percent of the capital cost for EPA Method 9 opacity testing system. The capital recovery factor is based on a 6-year equipment life and a 10 percent interest rate.

(j) Capital recovery = capital recovery factor (0.26360) x capital cost for EPA Method 9 opacity testing system.

(k) Assume 100 mi/hip, 2 trips/yr, and 10/20 mi/lt.

(l) Overhead = 60 percent of labor for quarterly EPA Method 9 opacity readings (based on standard OAQPS cost procedures).

(m) Capital recovery = capital recovery factor (0.26360) x capital cost for EPA Method 9 opacity testing system. The capital recovery factor is based on a 6-year equipment life and a 10 percent interest rate.

TABLE 4. (continued)

Parameters	Monitoring Option 2A		Monitoring Option 2B		Monitoring Option 2C		Monitoring Option 2D	
	CO2 and HCl CEMS w/o Appendix F Parameter monitoring for combustor & w/dry scrubber	CO2 CEMS w/o Appendix F Parameter monitoring for combustor & w/dry scrubber	CO2 CEMS w/o Appendix F Parameter monitoring for combustor & w/dry scrubber	CO2 CEMS w/o Appendix F Parameter monitoring for combustor & w/dry scrubber	Testing Option A	Testing Option B	Testing Option A	Testing Option B
Initial and annual/ skip test for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, opacity, qulity test for opacity	Annual Inspect.; initial test for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, opacity, qulity test for opacity	Annual Inspect.; initial test for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, opacity, qulity test for opacity	Annual Inspect.; initial test for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, opacity, qulity test for opacity	Annual Inspect.; initial test for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, opacity, qulity test for opacity	Initial and annual/ skip test for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, opacity, qulity test for opacity	Initial and annual/ skip test for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, opacity, qulity test for opacity	Initial and annual/ skip test for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, opacity, qulity test for opacity	Initial and annual/ skip test for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, opacity, qulity test for opacity
A. Capital Costs, \$								
1. Parameter monitoring (a)	15,654	15,654	18,894	18,894	See capital costs for Monitoring Option 2B, Testing Option A	See capital costs for Monitoring Option 2B, Testing Option B	18,894	18,894
2. Process monitoring (b)	0	0	0	0	0	0	31,800	31,800
3. CEMS (b)							0	0
a. CO and O2 CEMS	93,300	93,300	93,300	93,300			0	0
b. HCl CEMS	85,800	85,800	0	0			600	600
4. EPA Method 9 opacity testing equipment (c)	600	600	600	600			600	600
5. Total capital cost	193,354	193,354	112,794	112,794			51,234	51,234
B. Annual Costs, \$/yr								
1. Parameter monitoring (a)	6,082	6,082	6,082	6,082	See annual costs for Monitoring Option 2B, Testing Option A	See annual costs for Monitoring Option 2B, Testing Option B	7,720	7,720
2. Process monitoring (b)	0	0	0	0			0	0
3. Incinerator service inspection (d)	0	500	0	500			0	500
4. CEMS (b)							0	0
a. CO and O2 CEMS	22,681	22,681	22,691	22,691			0	0
b. HCl CEMS	21,510	21,510	0	0			0	0
5. Stack testing							18,800	18,800
a. Stack emission test (e)	16,800	16,800	2,350	18,800	2,350	2,350	528	528
b. In-house EPA Method 9 opacity testing							600	600
i. Operating labor (f)	628	628	628	628	600	600	40	40
ii. Registration/certification (g)	600	600	40	40	29	29	29	29
iii. Travel (h)	40	40	24	24	24	24	24	24
iv. Overhead (i)	29	29	158	158	158	158	158	158
v. Taxes, insur., and admin. (j)	24	24	158	158	158	158	158	158
vi. Capital recovery (k)	158	158	50,590	50,590	34,640	34,640	35,906	35,906
4. Total annual cost	70,462	54,512						

(a) See Table 6 for details. Parameter monitoring costs do not include pH meter or lime monitoring in those cases where there is an HCl CEMS.

(b) See Table 3 for details.

(c) Abbrev level, high quality compass, range finder, binoculars, and stopwatch.

(d) Testing Option B costs include cost of incinerator service inspection (annual-\$500; quarterly-\$2,000) when no CO202 monitoring system.

(e) Test costs = \$8,000 for PM test, \$21,000 for CDD/CDF test, \$5,000 for metals test, \$4,000 for CO test, and \$1,000 for opacity test (based on EPA cost estimates).

(f) For skip testing, assume 8 sets of tests over a 20-year period.

(g) For registration/certification, assume 5 day, 8 hr/d, and 12 hr.

(h) Assume 1300/Class and 2 classes/year.

(i) Assume 100 min/hr, 2 trips/wk, and \$0.20/ml.

(j) Overhead = 60 percent of labor for quarterly EPA Method 9 opacity testing system (based on standard OAOPB cost procedures).

(k) Capital recovery = capital recovery factor (0.26340) x capital cost for EPA Method 9 opacity testing system. The capital recovery factor is based on a 5-year equipment life and a 10 percent interest rate.

TABLE 4. (continued)

Parameters	Monitoring Option 3 Single measurement parameter monitoring for combustor & wet/dry scrubber		Monitoring Option 4A Redundant measurement parameter monitoring for combustor & wet/dry scrubber		Monitoring Option 4B Single measurement parameter monitoring for combustor & wet/dry scrubber	
	Testing Option A	Testing Option B	Testing Option A	Testing Option B	Testing Option A	Testing Option B
Initial and annual/ skip test for PM, CO, CDDICDF, HCl, Ph, Cd, Hg, opacity, quity test for opacity	Initial Inspec.; Initial test for PM, CO, CDDICDF, HCl, Ph, Cd, Hg, opacity, quity test for opacity	Initial test for PM, CO, CDDICDF, HCl, Ph, Cd, Hg, opacity, annual/ skip test for PM, CO, HCl; quity test for opacity	Initial test for PM, CO, CDDICDF, HCl, Ph, Cd, Hg, opacity, annual/ skip test for PM, CO, HCl; quity test for opacity	Initial Inspec.; Initial test for PM, CO, CDDICDF, HCl, Ph, Cd, Hg, opacity, annual/ skip test for PM, CO, HCl; quity test for opacity	Initial test for PM, CO, CDDICDF, HCl, Ph, Cd, Hg, opacity, annual/ skip test for PM, CO, HCl; quity test for opacity	Initial test for PM, CO, CDDICDF, HCl, Ph, Cd, Hg, opacity, annual/ skip test for PM, CO, HCl; quity test for opacity
A. Capital Costs, \$						
1. Parameter monitoring (a)	18,894	18,894	40,313	40,313	18,894	18,894
2. Process monitoring (b)	0	0	0	0	0	0
3. CEMS (b)	0	0	0	0	0	0
a. CO and O ₂ CEMS	0	0	0	0	0	0
b. HCl CEMS	0	0	600	600	600	600
4. EPA Method 9 opacity testing equipment (c)	600	600	600	600	600	600
5. Total capital cost	18,994	19,494	40,913	40,913	19,494	19,494
B. Annual Costs, \$/yr						
1. Parameter monitoring (a)	7,720	7,720	28,648	28,648	7,720	7,720
2. Process monitoring (b)	0	0	0	0	0	0
3. Incinerator service inspection (d)	0	2,000	0	2,000	0	2,000
4. CEMS (b)	0	0	0	0	0	0
a. CO and O ₂ CEMS	0	0	0	0	0	0
b. HCl CEMS	0	0	0	0	0	0
5. Stack testing						
a. Stack emission test (e)	16,800	2,350	8,300	2,350	8,300	2,350
b. In-house EPA Method 9 opacity testing						
i. Operating labor (f)	528	528	528	528	528	528
ii. Registration/certification (g)	600	600	600	600	600	600
iii. Travel (h)	40	40	40	40	40	40
iv. Overhead (i)	23	23	23	23	23	23
v. Taxes, insur., and admin. (j)	24	24	24	24	24	24
vi. Capital recovery (k)	158	158	158	158	158	158
4. Total annual cost	27,699	13,449	38,327	34,377	17,399	13,449

(a) See Table 6 for details. Parameter monitoring costs do not include pH meter or lime monitoring in those cases where there is an HCl CEMS.

(b) See Table 5 for details.

(c) Abbrev level, high quality compass, range finder, binoculars, and stopwatch.

(d) Testing Option B costs include cost of insulator service inspection (annual—\$500; quarterly—\$2,000) when no COO2 monitoring system.

(e) Test costs = \$8,000 for PM test, \$21,000 for CDDICDF test, \$5,000 for CO test, and \$1,000 for opacity test (based on EPA cost estimates).

(f) For skip testing, assume 8 sets of tests over a 20-year period.

(g) For registration/certification, assume 5 days, 8 hr/day, and \$12/hr.

(h) Assume \$100/mile, 2 trips/yr, and \$0.20/ml.

(i) Overhead = 60 percent of labor for quarterly EPA Method 9 opacity readings (based on standard OAQPS cost procedures).

(j) Taxes, insurance, and admin. = 4 percent of the capital cost for EPA Method 9 opacity testing system. The capital recovery factor is based on a 5-year equipment life and a 10 percent interest rate.

(k) Capital recovery = capital recovery factor (0.20380) x capital cost for EPA Method 9 opacity testing system.

TABLE 5. CAPITAL AND ANNUAL COSTS FOR CEMS AND PROCESS MONITORING SYSTEMS^a

Parameters	CO & O ₂ (with App. F); opacity (without App. F)	CO & O ₂ (without App. F)	CO, O ₂ , & opacity (without App. F)	CO & O ₂ (without App. F)	CO & O ₂ (without App. F)
A. Capital Costs, \$					
1. Planning	2,500	2,300	2,500	2,300	900
2. Select type of equipment	1,700	1,500	1,700	1,500	1,500
3. Provide support facilities	12,000	12,000	12,000	10,000	2,900
4. Purchased equipment cost	89,000	69,000	89,000	69,000	20,000
5. Install and check CEMS	5,000	4,000	5,000	4,000	2,000
6. Perf. spec. tests (certif.)	7,000	6,000	7,000	6,000	1,400
7. Prepare QA/QC plan (b)	1,000	1,000	600	500	500
8. Total capital cost	118,200	95,800	117,800	93,300	29,200
B. Annual Costs, \$/yr					
1. Operation and maintenance	10,000	8,000	9,000	6,000	4,000
2. Annual RATA (b),(c)	6,000	6,000	0	0	0
3. Quarterly CGA's (b),(d)	3,900	3,900	0	0	0
4. Recordkeeping and reporting	2,000	1,500	2,000	1,000	1,000
5. Annual review and update	1,000	1,000	1,000	1,000	1,000
6. Taxes, insurance, and admin. (b),(e)	4,728	3,832	4,712	3,732	1,168
7. Capital recovery (b),(f)	13,884	11,253	13,837	10,959	3,430
8. Total annual cost	41,512	35,485	30,549	22,691	10,598

(a) Estimated costs provided by EPA/EMC. (7),(8)

(b) Cost associated with Appendix F requirements.

(c) RATA = Relative Accuracy Test Audit.

(d) CGA = Cylinder Gas Audit.

(e) Taxes, insurance, and admin. = 4 percent of total capital cost (based on standard OAQPS cost procedures).

(f) Capital recovery = capital recovery factor (0.11746) x total capital cost for CEMS or process monitoring system (based on standard OAQPS cost procedures).

The capital recovery factor is based on a 20-year equipment life and a 10 percent interest rate.

TABLE 5. (continued)

Parameters	HCI (with App. F)	HCI (without App. F)	CO & O2 process monitoring (with extensive correlation testing)	CO & O2 process monitoring (without extensive correlation testing)
A. Capital Costs, \$				
1. Planning	2,300	2,300	2,300	2,300
2. Select type of equipment	1,500	1,500	1,500	1,500
3. Provide support facilities	12,000	10,000	3,000	3,000
4. Purchased equipment cost	61,500	61,500	22,000	22,000
5. Install and check CEMS	4,000	4,000	2,000	2,000
6. Perf. spec. tests (certif.)	6,000	6,000	6,000	500
7. Prepare QA/QC plan (b)	1,000	500	1,000	500
8. Total capital cost	88,300	85,800	37,800	31,800
B. Annual Costs, \$/yr				
1. Operation and maintenance	8,000	6,000	7,000	2,000
2. Annual RATA (b),(c)	6,000	0	6,000	0
3. Quarterly CGA's (b),(d)	3,900	0	3,000	0
4. Recordkeeping and reporting	1,500	1,000	1,000	1,000
5. Annual review and update	1,000	1,000	1,000	0
6. Taxes, insurance, and admin. (b),(e)	3,532	3,432	1,512	1,272
7. Capital recovery (b),(f)	10,372	10,078	4,440	3,735
8. Total annual cost	34,304	21,510	23,952	8,007

(a) Estimated costs provided by EPA/EMC. (7),(8)

(b) Cost associated with Appendix F requirements.

(c) RATA = Relative Accuracy Test Audit.

(d) CGA = Cylinder Gas Audit.

(e) Taxes, Insurance, and admin. = 4 percent of total capital cost (based on standard OAQPS cost procedures).

(f) Capital recovery = capital recovery factor (0.11746) x total capital cost for CEMS or process monitoring system (based on standard OAQPS cost procedures). The capital recovery factor is based on a 20-year equipment life and a 10 percent interest rate.

Planning costs were estimated to be \$900 for the opacity monitor and \$2,300 each for the CO/O₂ CEMS and the HCl CEMS. Planning costs were estimated to be \$200 higher (\$2,500) if an opacity monitor is added to the CO/O₂ CEMS.

The cost for selecting the type of equipment was estimated to be \$1,500 each for the opacity monitor, CO/O₂ CEMS, and HCl CEMS. The cost was estimated to be \$200 higher (\$1,700) if an opacity monitor is added to the CO/O₂ CEMS.

The costs for providing support facilities were estimated to be \$2,900 for the opacity monitor and \$12,000 each for the CO/O₂ CEMS and HCl CEMS with Appendix F requirements. Costs were not expected to increase if an opacity monitor is added to the CO/O₂ CEMS. The costs drop to \$10,000 if Appendix F requirements are excluded (unless an opacity monitor is included with the CO/O₂ CEMS, in which case costs remain at \$12,000).

The costs to install and check the CEMS were estimated to be \$2,000 for the opacity monitor and \$4,000 each for the CO/O₂ CEMS and HCl CEMS. The cost was estimated to increase to \$5,000 if an opacity monitor is added to the CO/O₂ CEMS.

Performance specification test costs were estimated to be \$1,400 for the opacity monitor and \$6,000 each for the CO/O₂ CEMS and HCl CEMS. The cost was estimated to be \$1,000 higher (\$7,000) if an opacity monitor is added to the CO/O₂ CEMS.

The costs to prepare a QA/QC plan were estimated to be \$500 each for the opacity monitor, CO/O₂ CEMS, and HCl CEMS without Appendix F requirements. The cost was estimated to increase to \$600 if an opacity monitor is added to the CO/O₂ CEMS. With Appendix F requirements, the cost is \$1,000 for CO/O₂ CEMS and HCl CEMS. Costs were not expected to increase if an opacity monitor is added to the CO/O₂ CEMS.

B. Annual Costs

The annual costs for CO and HCl CEMS and opacity monitors are presented in Table 5 and discussed in this section. Annual costs include operation and maintenance, indirect costs, and ancillary costs, such as annual relative accuracy test audit (RATA), quarterly cylinder gas audits (CGA's), recordkeeping and reporting, and annual review and update.¹

Operation and maintenance costs were estimated to be \$4,000 for the opacity monitor and \$6,000 each for the CO/O₂ CEMS and HCl CEMS without Appendix F requirements. Operation and maintenance costs increase to \$8,000 each for the CO/O₂ CEMS and HCl CEMS if Appendix F requirements are included. If an opacity monitor is added to the CO/O₂ CEMS, costs increase to \$9,000 without Appendix F and \$10,000 with Appendix F.¹

Indirect annual costs (i.e., property taxes, insurance, administrative, and capital recovery costs) were estimated using standard cost factors from the Control Cost Manual developed by EPA's Office of Air Quality Planning and Standards (OAQPS).³ The property tax, insurance, and administrative costs were estimated as 4 percent of the capital cost for the CEMS and opacity monitor.³ The capital recovery cost was estimated as a product of a capital recovery factor (CRF) and the capital cost for the CEMS and opacity monitor.³ Assuming a 20-year equipment life and a 10 percent interest rate, the CRF was estimated to be 0.11746, using an equation from the OAQPS Control Cost Manual.³

The costs for annual RATA and quarterly CGA's only apply when Appendix F is required. The cost for annual RATA was estimated to be \$6,000, while the cost for quarterly CGA's was estimated to be \$3,900.¹

Recordkeeping and reporting costs were estimated to be \$1,000 each for the opacity monitor, CO/O₂ CEMS, and HCl CEMS without Appendix F requirements. Costs increase to \$1,500 for the CO/O₂ CEMS and HCl CEMS if Appendix F requirements are included. Recordkeeping and reporting costs were estimated to increase to \$2,000 if an opacity monitor is added to the CO/O₂ CEMS, with or without Appendix F requirements.¹

Annual review and update costs were estimated to be \$1,000 for each of the monitors with or without Appendix F requirements. Costs were not expected to increase if an opacity monitor is added to the CO/O₂ CEMS.¹

IV. CO/O₂ Process Monitors

Cost estimates for CO process monitors were obtained from EPA/EMC.¹ An O₂ process monitor was included with the CO process monitor in estimating the costs because an O₂ process monitor would be needed to correct CO measurements.

The costs for the CO/O₂ process monitors are presented both with and without extensive correlation testing. As mentioned in Section II, CO/O₂ process monitors are far less sensitive than the CO/O₂ CEMS and, thus, precision and accuracy would be reduced. If measurements are to be used for direct enforcement of the CO limit, detailed QA/QC procedures must be prepared and implemented and performance specification tests must be conducted to ensure that the portable devices are calibrated properly at all times. Alternatively, the CO/O₂ process monitor could be used as an exceedance monitor, in which the CO concentration would be determined during the initial performance test and the process monitor would be calibrated to it, establishing a type of parameter limit.¹

A. Capital Costs¹

The capital costs for the CO/O₂ process monitor are presented in Table 5 and discussed in this section. Capital costs include the PEC and ancillary capital costs, such as planning, selecting the type of equipment, providing support facilities, installing and checking the process monitor, performance specification tests (certification), and preparing a QA/QC plan.

The PEC for the process monitor was estimated to be \$22,000. The ancillary costs for planning (\$2,300), selecting the type of equipment (\$1,500), providing support facilities (\$3,000), and installing and checking the process monitor (\$2,000) are not affected by whether the CO/O₂ process monitor is used to establish continuous compliance with the CO limit or to monitor exceedances. However, the cost to conduct performance specification tests was estimated to be only \$500 without extensive correlation testing, compared to \$6,000 with extensive correlation testing. Additional QA/QC is required if the monitor is used to establish continuous compliance. The QA/QC requirements would cost \$1,000 if the process monitor is used to establish continuous compliance, compared to \$500 if the process monitor is used only to monitor exceedances.

B. Annual Costs

The annual costs for the CO/O₂ process monitor are presented in Table 5 and discussed in this section. Annual costs include operation and maintenance, indirect costs, and ancillary annual costs, such as annual RATA, quarterly CGA's, recordkeeping and reporting, and annual review and update.¹

Operation and maintenance costs were estimated to be \$2,000 for the process monitor without the extensive correlation testing requirements. Operation and maintenance costs increase to \$7,000 if correlation testing is included.¹

Indirect annual costs (i.e., property taxes, insurance, administrative, and capital recovery costs) were estimated using standard OAQPS cost factors from the OAQPS Control Cost Manual. The property tax, insurance, and administrative costs were estimated as 4 percent of the capital cost for the process monitor.³ The capital recovery cost was estimated as a product of a CRF and the capital cost for the process monitor.³ Assuming a 20-year equipment life and a 10 percent interest rate, the CRF was estimated to be 0.11746.³

The costs for annual RATA, quarterly CGA's, and annual review and update only apply when extensive correlation testing and QA/QC is performed to allow the CO/O₂ process monitor to establish continuous compliance with the CO emission limit. The costs for annual RATA, quarterly CGA's, and annual review and

update were estimated to be \$6,000, \$3,000, and \$1,000, respectively.¹

Recordkeeping and reporting costs were estimated to be \$1,000 regardless of correlation testing and QA/QC requirements.¹

V. Parameter Monitoring

Where CEMS and process monitors are not available to measure specific pollutants or surrogate pollutants, or where the CEMS or process monitors are very expensive relative to the size of the pollution source being regulated, monitoring of operating parameters can provide a less expensive indication that air pollution control equipment and practices are functioning properly to minimize air pollution. Redundant measurement allows for greater confidence in measurement as is necessary for compliance purposes. Single measurement is considered adequate for identifying exceedances only.

A. Capital Costs

This section discusses the capital costs associated with both parameter monitoring options--redundant and single measurement. Capital costs for parameter monitoring equipment and other ancillary capital costs are presented in Table 6 and discussed below.

1. Equipment Costs. Equipment costs have been estimated for both the single measurement and redundant measurement options. The equipment costs for monitors in single parameter monitoring systems are discussed in the paragraphs below. The equipment costs for redundant parameter monitoring systems were estimated to be 120 percent of the equipment costs for single parameter monitoring systems.¹

The single parameter monitoring system for the good combustion emission control option would include single sets of temperature monitors for the secondary chamber and a weight scale.

The single parameter monitoring system for the wet scrubber emission control option would include a weight scale, as well as monitors for secondary chamber temperature, scrubber exit temperature, scrubber liquid pH, scrubber liquid flow rate, and energy input to the scrubber (e.g., pressure drop or atomizer power input).

The single parameter monitoring system for the dry scrubber emission control option would include a weight scale, as well as monitors for secondary chamber temperature and PM control device inlet temperature. The flow rates for the acid gases sorbent (i.e., lime) and the Hg and dioxin/furan (CDD/CDF) sorbent (i.e., activated carbon) would also be monitored.

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TABLE 6. CAPITAL AND ANNUAL COSTS FOR PARAMETER MONITORING SYSTEMS^a

Parameter(s)	Dry scrubber parameter monitoring (temp., gas flow, charge wt., lime flow, carbon flow measurement)			Combination wet/dry scrubber parameter monitoring (temp., gas flow, charge wt., pH, liquid flow, pressure drop, lime flow, carbon flow measurement)		
	Redundant parameter monitoring		Single parameter monitoring With lime monitoring	Redundant parameter monitoring		Single parameter monitoring With pH meter, lime monitoring
	With lime monitoring	Without lime monitoring		With lime monitoring	Without pH meter, lime monitoring	
A. Capital Costs, \$						
1. Planning	1,000	500	500	1,000	500	500
2. Select type of equipment	1,000	300	300	1,000	300	300
3. Provide support facilities	2,000	1,000	1,000	2,000	1,000	1,000
4. Purchased equipment cost (b)-(f)	13,608	11,340	11,340	18,533	15,444	12,204
5. Install and check equipment (b), (g)	780	650	650	780	650	650
6. Perf. spec. tests (certif.)	16,000	500	500	16,000	500	500
7. Prepare QA/QC plan (h)	1,000	500	500	1,000	500	500
8. Total capital cost	35,388	14,790	14,790	40,313	18,894	15,654
B. Annual Costs, \$/yr						
1. Operation and maintenance (i)	7,300	3,614	2,590	7,300	3,745	2,617
2. Annual reverification (h)	6,000	0	0	6,000	0	0
3. Quarterly QA (h)	6,000	0	0	6,000	0	0
4. Recordkeeping and reporting	2,000	1,000	1,000	2,000	1,000	1,000
5. Annual review and update	1,000	0	0	1,000	0	0
6. Taxes, insurance, and admin. (j)	1,416	592	592	1,613	756	626
7. Capital recovery (k)	4,157	1,737	1,737	4,735	2,219	1,839
8. Total annual cost	27,872	6,942	5,918	28,648	7,720	6,082

^aSee footnotes after the table.

TABLE 6. continued

Parameters	Good combustion parameter monitoring (temp., gas flow, charge wt. measurement)		Wet scrubber parameter monitoring wt., pH, liquid flow, pressure drop measurement)	
	Redundant parameter monitoring	Single parameter monitoring	Redundant parameter monitoring	Single parameter monitoring
A. Capital Costs, \$				
1. Planning	1,000	500	1,000	500
2. Select type of equipment	1,000	300	1,000	300
3. Provide support facilities	2,000	1,000	2,000	1,000
4. Purchased equipment cost (b)-(f)	13,478	11,232	18,403	15,336
5. Install and check equipment (b),(g)	780	650	780	650
6. Perf. spec. tests (certif.)	16,000	500	16,000	500
7. Prepare QA/QC plan (h)	1,000	500	1,000	500
8. Total capital cost	35,258	14,682	40,183	18,786
B. Annual Costs, \$/yr				
1. Operation and maintenance (i)	7,300	1,562	7,300	1,693
2. Annual reverification (h)	6,000	0	6,000	0
3. Quarterly QA (h)	6,000	0	6,000	0
4. Recordkeeping and reporting	2,000	1,000	2,000	1,000
5. Annual review and update	1,000	0	1,000	0
6. Taxes, insurance, and admin. (j)	1,410	587	1,607	751
7. Capital recovery (k)	4,141	1,725	4,720	2,207
8. Total annual cost	27,852	4,874	28,627	5,651

See footnotes after the table.

TABLE 6. (continued)

a	Estimated costs provided by EPA/EMC, except where footnoted below.
b	Cost of equipment/installation for redundant parameter monitoring = 120 percent of equipment/installation for single parameter monitoring as per EPA/EMC.
c	Single parameter monitoring equipment for good combustion: 4' x 4' scale w/ digital display and ramp (\$3,000); data logger, 200 ft thermocouple wire, computer, data logger/computer interface, logging and reporting software, and printer (\$7,400). Taxes and freight = 8 percent of equipment cost (\$832).
d	Single parameter monitoring equipment for wet scrubbers: 4' x 4' scale w/ digital display and ramp (\$3,000); data logger, 300 ft thermocouple wire, 300 ft signal wire, two liquid flow transducers, one pressure transducer, computer, data logger/computer interface, logging and reporting software, and printer (\$8,200); controller element and transmitter for pH meter (\$3,000). Taxes and freight = 8 percent of equipment cost (\$1,136 with pH meter, \$896 without pH meter).
e	Single parameter monitoring equipment for dry scrubbers: 4' x 4' scale w/ digital display and ramp (\$3,000); data logger, 300 ft thermocouple wire, computer, data logger/computer interface, logging and reporting software, and printer (\$7,500). Taxes and freight = 8 percent of equipment cost (\$840).
f	Single parameter monitoring equipment for wet/dry scrubber combinations: 4' x 4' scale w/ digital display and ramp (\$3,000); data logger, 400 ft thermocouple wire, 300 ft signal wire, two liquid flow transducers, one pressure transducer, computer, data logger/computer interface, logging and reporting software, and printer (\$8,300); controller element and transmitter for pH meter (\$3,000). Taxes and freight = 8 percent of equipment cost (\$1,144 with pH meter, \$904 without pH meter).
g	Installation for single parameter monitoring equipment = 3 hours installation for scale, according to vendor (\$150); estimated 8 hours installation plus travel and per diem for parameter monitoring system (\$500).
h	Cost associated with Appendix F requirements.
i	Operation and maintenance = operating labor + maintenance materials/supplies + overhead For good combustion, wet scrubbers, dry scrubbers, and wet/dry scrubber combinations: Operating Labor (recording charge weight and hourly rate) = 10 sec/load x 1 hr/3,600 sec x 8 loads/hr x 8 hr/d x 320 d/yr x \$12/hr = \$683. For dry scrubbers and wet/dry scrubber combinations only: Operating Labor (recording lime or carbon flow measurement) = 5 min/4 hr x 1 hr/60 min x 8 hr/d x 320 d/yr x \$12/hr = \$640. Maintenance materials and supplies = 2 percent of total capital costs. Overhead = 60 percent of labor and maintenance costs.
j	Taxes, insurance, and admin. = 4 percent of total capital cost.
k	Capital recovery = capital recovery factor (0.11746) x total capital cost for parameter monitoring system. The capital recovery factor is based on a 20-year equipment life and a 10 percent interest rate.

The single parameter monitoring system for the wet/dry scrubber combination emission control option would include those monitors listed above for both the wet and dry scrubber emission control options.

The readings from the various monitors would be compiled and recorded using a data acquisition system (DAS), consisting of a data logger (\$3,000) with computer interface, computer (\$3,000), logging and reporting software (\$1,000), and printer (\$300). Monitoring readings for wet scrubbers and wet/dry scrubber combinations would also require signal wire (\$75).⁴

a. Temperature monitors. Higher secondary chamber temperatures promote good combustion of volatiles released from the primary chamber and minimize CO and CDD/CDF emissions. Monitoring of secondary chamber temperature, therefore, would provide an indication of combustion conditions in the incinerator. A minimum secondary chamber temperature could be determined during the initial compliance test. The temperature could be monitored continuously with a thermocouple and recorded using a DAS. The PEC for such a temperature monitoring system for the good combustion emission control option was estimated to be \$100 for the thermocouples and thermocouple wire.⁴

Monitoring the exit temperature from the wet scrubber could be used as an indication of wet scrubber performance with regard to Hg emissions because increased scrubber exit temperatures may lead to higher Hg emissions. A maximum scrubber exit temperature could be determined during the initial compliance test. The temperature monitoring system for the wet scrubber emission control option would consist of thermocouples and thermocouple wire for the secondary chamber and scrubber exit. The PEC for such a system was estimated to be \$150.⁴

A temperature monitor for the inlet to the dry scrubber PM control device could ensure that CDD/CDF formation is minimized (increased inlet temperatures may lead to higher CDD/CDF emissions). A maximum value for the inlet temperature could be determined during the initial compliance test. The temperature monitoring system for the dry scrubber emission control option would consist of thermocouples and thermocouple wire for the secondary chamber and PM control device inlet. The PEC for such a system was estimated to be \$150.⁴

A temperature monitoring system for the wet/dry scrubber combination emission control option would consist of thermocouples and thermocouple wire for the secondary chamber, wet scrubber exit, and dry scrubber PM control device inlet. The PEC for such a system was estimated to be \$200.⁴

b. Weight scale. Weighing the waste before charging would help the operator introduce uniform charges at the design rate, which would minimize overloading. Uniform charge weights

charged at regular intervals would promote good combustion and minimize CO and CDD/CDF emissions. Monitoring the charge rate could be used to indicate whether the incinerator has been overloaded. The weight of each waste charge and the time it was charged would be recorded. Maximum values for charge rate could be determined during the initial compliance test. For this analysis, it was assumed that most facilities would choose to use a floor scale to weigh the waste, either by weighing a cart that contains bags of waste or by manually placing on the scale the number of bags that the hopper can hold. According to two scale distributors, the PEC for a 4' x 4' scale with a digital display and one ramp would be \$3,000.⁴

c. pH monitor. Monitoring the pH of the scrubber liquid in the wet scrubber system would ensure that the scrubber liquid is at the optimal pH level for absorbing acid gases such as HCl. The pH of the scrubber liquid could be monitored continuously with a pH meter. A minimum pH value could be determined during the initial compliance test. The cost for a pH meter was estimated to be \$3,000 for the controller element and transmitter.⁵

d. Scrubber liquid flow rate monitor. Continued flow of scrubber liquid would ensure that the wet scrubber system is operating properly. Therefore, continuous monitoring of the scrubber liquid flow rate could serve as an indication of scrubber performance with regard to emissions of PM, lead (Pb), cadmium (Cd), and HCl. A minimum scrubber liquid flow rate could be determined during the initial compliance test. The cost for two liquid flow transducers to measure the scrubber liquid flow rate was estimated to be \$500.⁴

e. Energy input monitor. The energy input to the wet scrubber could be used as an indicator of the effectiveness of the scrubber in removing PM. Depending on the scrubber design, either pressure drop (expressed as inches of water column) or atomizer power input (expressed as amperage) could be used to measure energy input to the wet scrubber. Minimum values for the energy input could be determined during the initial compliance test. The cost for a pressure transducer to measure pressure drop was estimated to be \$200.⁴ Because a cost for monitoring the atomizer power input is not available (and is believed to be minimal), only the cost for monitoring pressure drop is presented in this analysis.

f. Lime flow rate monitoring. Continued flow of acid gases sorbent (i.e., lime) would ensure that the dry scrubber system is operating and that emissions of acid gases such as HCl are being controlled. Minimum values for lime flow rate could be determined during the initial compliance test. There is no equipment cost associated with monitoring the lime flow rate. The labor costs associated with recording the lime flow rate are presented in Section V.B.1 below.

g. Activated carbon flow rate monitoring. Continued flow of Hg and CDD/CDF sorbent (i.e., activated carbon) in the dry scrubber system would ensure that emissions of Hg and CDD/CDF are being controlled. Minimum values for activated carbon flow rate could be determined during the initial compliance test. There is no equipment cost associated with monitoring the activated carbon flow rate. The labor costs associated with recording the activated carbon flow rate are presented in Section V.B.1 below.

h. Installation costs. The installation cost for the single parameter monitoring systems discussed above (except for the weight scale) was estimated to be \$500, based on 8 hours of installation plus travel and per diem.⁴ According to a vendor, the installation cost for the weight scale would be \$150, based on 3 hours of installation.⁴ Installation costs for redundant parameter monitoring systems were estimated to be 120 percent of the cost of installation for single parameter monitoring systems.¹

i. Taxes and freight. Taxes and freight costs were estimated as 8 percent of the PEC for the DAS and the monitors, based on standard OAQPS cost procedures.³

2. Ancillary Costs. Ancillary capital costs for parameter monitoring systems were provided by EPA/EMC and include costs for planning, selecting the type of equipment, providing support facilities, conducting performance specification tests (i.e., certification), and preparing a QA/QC plan. Because the redundant measurement option includes additional, redundant devices for measuring operating parameters, the ancillary costs for the redundant measurement option were estimated to be higher compared to the single measurement option. Planning costs for parameter monitoring systems were estimated to be \$500 for the single measurement option and \$1,000 for the redundant measurement option. Selecting the type of monitoring equipment was estimated to cost \$300 for the single measurement option and \$1,000 for the redundant measurement option. Performance specification tests were estimated to cost \$500 for the single measurement option. The costs for performance specification tests were estimated to be substantially higher (\$16,000) for the redundant measurement option because of the initial extensive correlation testing necessary to establish continuous compliance under this monitoring option. Additional QA/QC would also be necessary to establish continuous compliance. Preparing a QA/QC plan for the parameter monitoring system was estimated to cost \$1,000 for the redundant measurement option, compared to \$500 for the single measurement option.¹

B. Annual Costs

This section discusses the annual costs associated with both parameter monitoring options--redundant and single measurement. The annual costs include operation and maintenance,

indirect annual costs, and ancillary annual costs. The costs are presented in Table 6 and discussed below.

1. Operation and Maintenance. Operation and maintenance costs include costs for operating labor, maintenance materials and supplies, and overhead. The operation and maintenance cost for redundant parameter monitoring systems was estimated to be \$7,300.¹ The operation and maintenance costs for single parameter monitoring systems are discussed below.

All four emission control options would require manual recording of the weight of each waste charge and the time it is charged. The dry scrubber and wet/dry scrubber combination emission control options would also require manual recording of lime and activated carbon flow rates. The readings from the other parameter monitors required under the four emission control options would be recorded automatically by the DAS. Therefore, annual labor costs would only be associated with monitoring charge rate, lime flow rate, and activated carbon flow rate.

As stated in Section V.A.1.b, monitoring the charge rate could be used as an indication of combustion conditions in the incinerator. The labor requirements to manually record the weight of each waste charge and the time it is charged (i.e., the charge rate) were estimated to be 10 seconds/load and 8 loads/hr⁴ for 8 hr/d (hr/d) and 320 d/yr (d/yr) at a wage rate of \$12/hr.⁴

As stated in Section V.A.1.f, monitoring the flow rate of lime could be used as an indication that the dry scrubber system is operating and that emissions of acid gases such as HCl are being controlled; as stated in Section V.A.1.g, monitoring the flow rate of activated carbon could be used as an indication that emissions of Hg and CDD/CDF are being controlled. The labor requirements to manually record lime and activated carbon flow measurements were estimated to be 10 minutes/4-hr period for 8 hr/d and 320 d/yr at a wage rate of \$12/hr.⁴

The annual costs for maintenance materials and supplies for parameter monitors were estimated as 2 percent of the capital cost for parameter monitors, based on standard OAQPS cost procedures.³

Overhead costs for parameter monitoring were estimated to be equal to 60 percent of the labor and maintenance costs associated with parameter monitoring.³

2. Indirect Costs. The property tax, insurance, and administrative costs were estimated as 4 percent of the capital cost for the parameter monitoring equipment.³ The capital recovery cost was estimated as a product of a CRF and the capital cost for the parameter monitoring equipment.³ Assuming a 20-year equipment life and a 10 percent interest rate, the CRF was estimated to be 0.11746.³

3. Ancillary Costs. Ancillary capital costs for parameter monitoring systems were provided by EPA/EMC and include costs for annual reverification, quarterly QA, recordkeeping and reporting, and annual review and update. All costs except recordkeeping and reporting apply only under the redundant measurement option. Annual reverification and quarterly QA were each estimated to cost \$6,000, while annual review and update was estimated to cost \$1,000. Recordkeeping and reporting costs were estimated to be higher under the redundant measurement option (\$2,000) than under the single measurement option (\$1,000).¹

VI. Incinerator Service Inspection

Routine maintenance service inspections of MWI's on a periodic basis would help keep the system operating efficiently, which would aid good combustion. Incinerator service requirements are included in those monitoring options where repeat stack emission testing is not required. Annual inspections are included in those monitoring options (Options 1 and 2) where CO CEMS or process monitors are required, while quarterly inspections are included in those monitoring options (Options 3 and 4) where CO CEMS or process monitors are not required. Based on information from incinerator maintenance contractors, the cost for a typical visit was estimated to be \$500; if the visits were conducted quarterly, the cost would be about 4 times that, or \$2,000.⁴

VII. Stack Testing

This section discusses the costs associated with stack testing, which includes stack testing of opacity and pollutant emissions.

A. EPA Method 9 Opacity Testing⁴

1. Capital Costs. This section discusses the capital costs for quarterly EPA Method 9 opacity testing, which is included as a monitoring option where monitors for opacity are not required (Monitoring Options 1C & D, 2C & D, and 4A & B for the good combustion and dry scrubber emission control options and all monitoring options for the wet scrubber and wet/dry scrubber combination emission control options). Method 9 testing of the opacity of stack emissions could be used as an indicator of good combustion and PM emission control. The capital cost for Method 9 testing equipment was estimated to be \$600. The equipment would include an abney level, a high quality compass, a range finder, binoculars, and a stopwatch and should last about 5 years.

2. Annual Costs. The annual cost for quarterly EPA Method 9 testing was estimated as a sum of the annual costs for (1) registration for a Method 9 training course (for certification), (2) labor to take the course, (3) travel to and

from the school site, (4) labor to take quarterly Method 9 readings, (5) overhead, and (6) indirect costs (i.e., property taxes, insurance, administrative, and capital recovery). Registration/certification costs were estimated at \$300/class, with two classes/yr. The labor requirements to take the course were estimated to be 8 hr/d for 5 d/yr at a wage rate of \$12/hr. The costs for travel and expenses to and from the school site were estimated at \$0.20/mile for 100 miles/round trip and 2 trips/yr. Annual operating labor requirements to take the quarterly EPA Method 9 readings were estimated to be 1 hr/reading for 1 reading/quarter (4 quarters/yr) at a wage rate of \$12/hr. Overhead costs were estimated to be equal to 60 percent of the labor costs for the quarterly readings. The property tax, insurance, and administrative costs were estimated as 4 percent of the capital cost for the EPA Method 9 testing equipment. The capital recovery cost was estimated as a product of a CRF and the capital cost for the EPA Method 9 testing equipment. Based on an estimated 5-year equipment life and a 10 percent interest rate, the CRF would be 0.26380.

B. Stack Emission Testing

In addition to continuous monitoring with CEMS and process monitors, pollutant emissions also could be measured during initial and periodic stack emission tests. Limits for operating parameters could be set during the initial test. Table 7 presents the stack emission tests and associated costs for PM, CDD/CDF, CO, HCl, metals (e.g., Pb, Cd, and Hg), and opacity.

TABLE 7. INDIVIDUAL COSTS FOR STACK EMISSION TESTS

Stack emission test	Costs, \$
EPA Method 5 (PM)	8,000
EPA Method 23 (CDD/CDF)	21,000
EPA Method 10 or 10B (CO)	4,000
EPA Method 26 (HCl)	5,000
EPA Method 29 (metals)	8,000
EPA Method 9 (opacity)	1,000

As noted in Section II, there are two stack testing options for each of the four monitoring options. These testing options are referred to as Testing Option A and Testing Option B.

Testing Option A includes initial and annual skip tests under each of the four monitoring options. Under Monitoring Options 1 through 3, the initial and annual/skip tests would be conducted for the same pollutants, except for the addition of CO stack tests under Monitoring Options 2 and 3 and HCl stack tests under Monitoring Options 1B-1D, 2, and 3. The CO test would

compensate for the absence of Appendix F requirements for the CO CEMS under Option 2 and the absence of the CO CEMS under Option 3. The HCl test would compensate for the absence of Appendix F requirements for the HCl CEMS under Option 2A and the absence of the HCl CEMS under the remaining monitoring options. Stack tests for HCl would be conducted only for the wet scrubber, dry scrubber, and wet/dry scrubber combination emission control options. Under Monitoring Option 4, after the initial test, annual/skip tests would be required only for PM and CO (and HCl for the wet scrubber, dry scrubber, and wet/dry scrubber combination emission control options).

With the annual/skip test requirement, stack emission tests would be performed for the first 3 years. If the test results showed that the facility was in compliance each of those 3 years, then subsequent testing would be done every third year. The total cost of annual/skip stack emission testing was estimated over a 20-year period (i.e., the total cost was divided by 20 to determine the annual cost). The costs were estimated in this manner in order to be consistent with the 20-year life assumed for the emission control and parameter monitoring equipment in estimating capital recovery costs. There would be eight sets of annual/skip tests over a 20-year period.

The testing requirements under Testing Option B are the same as those under Testing Option A, except that annual/skip tests are replaced with incinerator service inspections. Because only initial testing is required under Testing Option B, the total cost of the initial testing was divided by 20 to determine the annual cost of the initial tests over a 20-year period (to be consistent with the 20-year life of the emission control and parameter monitoring equipment).

VIII. Combustor and Control Costs

In order to provide some context in which to examine the testing and monitoring costs, capital and annual costs were also estimated for combustors and for the four emission control options--good combustion control, wet scrubbers, dry scrubbers, and wet/dry scrubber combinations. Tables of the combustor and emission control costs are provided for comparison in Table 8.

Costs for good combustion control and low-efficiency wet scrubbers were estimated for a small 100 pound per hour (lb/hr) intermittent model MWI. Costs for moderate-efficiency wet scrubbers were estimated for a medium-size 350 lb/hr intermittent model MWI. Costs for high-efficiency wet scrubbers were estimated for a large 1,000 lb/hr onsite model MWI. Costs for dry scrubbers and wet/dry scrubber combinations were estimated for a medium-size 350 lb/hr intermittent model MWI and a large 1,000 lb/hr onsite model MWI. The wet scrubber included in the wet/dry scrubber combinations is a high-efficiency wet scrubber.

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TABLE 8. CAPITAL AND ANNUAL COMBUSTOR AND CONTROL COSTS FOR MWI'S

Parameters	Small intermittent	Medium intermittent	Large onsite
1. Design capacity, lb/hr	100	350	1,000
2. Exhaust gas flow rate, dscfm	317	1,108	3,165
3. Operating hours, hrs/yr	1,200	1,300	2,135
4. Total capital cost, \$			
a. Combustor	59,162	151,854	335,158
b. Good combustion	43,952	a	a
c. Low efficiency wet scrubber	175,470	200,145	264,300
d. Moderate efficiency wet scrubber	201,029	233,704	318,659
e. High efficiency wet scrubber	249,418	285,843	380,548
f. Dry scrubber with carbon	441,774	495,443	633,379
g. Dry/wet scrubber with carbon	691,192	781,286	1,013,927
4. Total annual cost, \$/yr			
a. Combustor	32,594	55,116	118,408
b. Good combustion	9,608	a	a
c. Low efficiency wet scrubber	45,902	63,152	108,002
d. Moderate efficiency wet scrubber	52,530	71,830	122,010
e. High efficiency wet scrubber	62,517	83,142	136,767
f. Dry scrubber with carbon	97,644	114,129	167,590
g. Dry/wet scrubber with carbon	160,161	197,271	304,357

^aAssumes good combustion control at baseline.

Operating hr/yr were estimated for each model MWI using assumptions regarding actual operating hr/d (0.5 hr/d for preheat and 3 hr/d for burndown) and actual operating d/yr (225 d/yr for the small model, 232 d/yr for the medium-size model, and 324 d/yr for the large model).

The costs for combustors, good combustion control, and dry scrubbers were estimated using cost algorithms provided in various memoranda.⁶⁻⁸ The costs for wet scrubbers were estimated using cost equations that were developed based on recent cost information provided by wet scrubber vendors.⁹ The costs for wet/dry scrubber combinations were estimated as a sum of the costs for dry scrubbers and high-efficiency wet scrubbers.

IX. References

1. Memorandum from Bivins, D., EPA/EMC, to Copland, R., EPA/CG. January 24, 1997. Emission Measurement Center Cost Estimates for the Medical Waste Incinerator Project.

2. Memorandum from Holloway, T., MRI, to Copland, R., EPA/CG. May 20, 1996. Testing and Monitoring Options and Costs for MWI's--Methodology and Assumptions.
3. OAQPS Control Cost Manual. 4th Edition. U. S. Environmental Protection Agency. Research Triangle Park, NC. Publication No. PA-450/3-90-006. January 1990.
4. Memorandum from Holloway, T. and Shoraka-Blair, S., MRI, to Copland, R., EPA/SDB. March 30, 1994. Testing and Monitoring Options and Costs for Medical Waste Incinerators.
5. Memorandum from Toney, M., EPA/SCGA, to Telander, J., EPA/MICG. January 13, 1995. Enhanced Monitoring for Pulp and Paper.
6. Memorandum from Randall D., MRI, to Copland, R., EPA/CG. January 29, 1996. Operating Parameters and Costs for Model Medical Waste Incinerators.
7. Memorandum from Randall D., MRI, to Copland, R., EPA/CG. January 29, 1996. Revised Costs for Dry Injection/Fabric Filter Controls for MWI's.
8. Memorandum from Randall D., MRI, to Copland, R., EPA/CG. January 29, 1996. Revised Costs for Secondary Chamber Retrofits for MWI's.
9. Memorandum from Holloway, T., MRI, to MWI Project File. September 7, 1995. Approach Used to Estimate Capital and Annual Costs for MWI Wet Scrubbers.

Attachments

APPENDIX A
TESTING AND MONITORING OPTIONS

GOOD COMBUSTION CONTROL

Option 1A (Continuous Compliance) :

Monitoring:

CO/O₂ CEMS with Appendix F requirements
Opacity monitor without Appendix F requirements
HCl CEMS with Appendix F requirements
Combustor operating parameters (charge rate; secondary chamber temperature)

Testing:

- A. Initial and annual/skip tests for PM, CDD/CDF, and opacity; only initial test for Hg
- B. Only initial tests for PM, CDD/CDF, Hg, and opacity; annual inspections

Option 1B (Continuous Compliance)

Monitoring:

CO/O₂ CEMS with Appendix F requirements
Opacity monitor without Appendix F requirements
Combustor operating parameters (charge rate; secondary chamber temperature)

Testing:

- A. Initial and annual/skip tests for PM, CDD/CDF, and opacity; only initial test for Hg
- B. Only initial tests for PM, CDD/CDF, Hg, and opacity; annual inspections

Option 1C (Continuous Compliance) :

Monitoring:

CO/O₂ CEMS with Appendix F requirements
Combustor operating parameters (charge rate; secondary chamber temperature)

Testing:

- A. Initial and annual/skip tests for PM, CDD/CDF, and opacity; only initial test for Hg; quarterly EPA Method 9 opacity tests
- B. Only initial tests for PM, CDD/CDF, Hg, and opacity; annual inspections; quarterly EPA Method 9 opacity tests

Option 1D (Continuous Compliance) :

Monitoring:

CO/O₂ "Process Monitoring System" with extensive performance specification tests and correlation testing Combustor operating parameters (charge rate; secondary chamber temperature)

Testing:

- A. Initial and annual/skip tests for PM, CDD/CDF, and opacity; only initial test for Hg; quarterly EPA Method 9 opacity tests
- B. Only initial tests for PM, CDD/CDF, Hg, and opacity; annual inspections; quarterly EPA Method 9 opacity tests

Option 2A (Exceedances) :

Monitoring:

CO/O₂ CEMS without Appendix F requirements

Opacity monitor without Appendix F requirements

HCl CEMS without Appendix F requirements

Combustor operating parameters (charge rate; secondary chamber temperature)

Testing:

- A. Initial and annual/skip tests for PM, CO, CDD/CDF, and opacity; only initial test for Hg
- B. Only initial tests for PM, CO, CDD/CDF, Hg, and opacity; annual inspections

Option 2B (Exceedances) :

Monitoring:

CO/O₂ CEMS without Appendix F requirements

Opacity monitor without Appendix F requirements

Combustor operating parameters (charge rate; secondary chamber temperature)

Testing:

- A. Initial and annual/skip tests for PM, CO, CDD/CDF, and opacity; only initial test for Hg
- B. Only initial tests for PM, CO, CDD/CDF, Hg, and opacity; annual inspections

Option 2C (Exceedances) :

Monitoring:

CO/O₂ CEMS without Appendix F requirements

Combustor operating parameters (charge rate; secondary chamber temperature)

Testing:

- A. Initial and annual/skip tests for PM, CO, CDD/CDF, and opacity; only initial test for Hg; quarterly EPA Method 9 opacity tests
- B. Only initial tests for PM, CO, CDD/CDF, Hg, and opacity; annual inspections; quarterly EPA Method 9 opacity tests

Option 2D (Exceedances):

Monitoring:

CO/O₂ "Process Monitoring System" without extensive performance specification and correlation tests
Combustor operating parameters (charge rate; secondary chamber temperature)

Testing:

- A. Initial and annual/skip tests for PM, CO, CDD/CDF, and opacity; only initial test for Hg; quarterly EPA Method 9 opacity tests
- B. Only initial tests for PM, CO, CDD/CDF, Hg, and opacity; annual inspections; quarterly EPA Method 9 opacity tests

Option 3 (Exceedances):

Monitoring:

Opacity monitor without Appendix F requirements
Combustor operating parameters (charge rate; secondary chamber temperature)

Testing:

- A. Initial and annual/skip tests for PM, CO, CDD/CDF, and opacity; only initial test for Hg
- B. Only initial tests for PM, CO, CDD/CDF, Hg, and opacity; quarterly inspections

Option 4A (Continuous Compliance):

Monitoring:

No CEMS

Parameter or Predictive Monitoring System (i.e., redundant measurements of combustor operating parameters)

Testing:

- A. Initial and annual/skip tests for PM and CO; only initial tests for CDD/CDF, Hg, and opacity; quarterly EPA Method 9 opacity tests
- B. Only initial tests for PM, CO, CDD/CDF, Hg, and opacity; quarterly inspections; quarterly EPA Method 9 opacity tests

Option 4B (Exceedances) :

Monitoring:

No CEMS

Combustor operating parameters (charge rate; secondary chamber temperature)

Testing:

- A. Initial and annual/skip tests for PM and CO; only initial tests for CDD/CDF, Hg, and opacity; quarterly EPA Method 9 opacity tests
- B. Only initial tests for PM, CO, CDD/CDF, Hg, and opacity; quarterly inspections; quarterly EPA Method 9 opacity tests

WET SCRUBBERS

Option 1A (Continuous Compliance):

Monitoring:

CO/O₂ CEMS with Appendix F requirements
HCl CEMS with Appendix F requirements
Combustor operating parameters (charge rate; secondary chamber temperature)
Wet scrubber operating parameters (exit temperature; scrubber liquid flow rate; energy input)

Testing:

- A. Initial and annual/skip tests for PM, CDD/CDF, Pb, Cd, Hg, and opacity; quarterly EPA Method 9 opacity tests
- B. Only initial tests for PM, CDD/CDF, Pb, Cd, Hg, and opacity; annual inspections; quarterly EPA Method 9 opacity tests

Option 1B (Continuous Compliance)

Monitoring:

CO/O₂ CEMS with Appendix F requirements
Combustor operating parameters (charge rate; secondary chamber temperature)
Wet scrubber operating parameters (exit temperature; scrubber liquid pH; scrubber liquid flow rate; energy input)

Testing:

- A. Initial and annual/skip tests for PM, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; quarterly EPA Method 9 opacity tests
- B. Only initial tests for PM, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; annual inspections; quarterly EPA Method 9 opacity tests

Option 1C (Continuous Compliance):

Monitoring:

CO/O₂ CEMS with Appendix F requirements
Combustor operating parameters (charge rate; secondary chamber temperature)
Wet scrubber operating parameters (exit temperature; scrubber liquid pH; scrubber liquid flow rate; energy input)

Testing:

- A. Initial and annual/skip tests for PM, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; quarterly EPA Method 9 opacity tests

- B. Only initial tests for PM, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; annual inspections; quarterly EPA Method 9 opacity tests

Option 1D (Continuous Compliance):

Monitoring:

CO/O₂ "Process Monitoring System" with extensive performance specification tests and correlation testing
Combustor operating parameters (charge rate; secondary chamber temperature)

Wet scrubber operating parameters (exit temperature; scrubber liquid pH; scrubber liquid flow rate; energy input)

Testing:

- A. Initial and annual/skip tests for PM, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; quarterly EPA Method 9 opacity tests
- B. Only initial tests for PM, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; annual inspections; quarterly EPA Method 9 opacity tests

Option 2A (Exceedances):

Monitoring:

CO/O₂ CEMS without Appendix F requirements

HCl CEMS without Appendix F requirements

Combustor operating parameters (charge rate; secondary chamber temperature)

Wet scrubber operating parameters (exit temperature; scrubber liquid flow rate; energy input)

Testing:

- A. Initial and annual/skip tests for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; quarterly EPA Method 9 opacity tests
- B. Only initial tests for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; annual inspections; quarterly EPA Method 9 opacity tests

Option 2B (Exceedances):

Monitoring:

CO/O₂ CEMS without Appendix F requirements

Combustor operating parameters (charge rate; secondary chamber temperature)

Wet scrubber operating parameters (exit temperature; scrubber liquid pH; scrubber liquid flow rate; energy input)

Testing:

- A. Initial and annual/skip tests for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; quarterly EPA Method 9 opacity tests
- B. Only initial tests for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; annual inspections; quarterly EPA Method 9 opacity tests

Option 2C (Exceedances) :

Monitoring:

CO/O₂ CEMS without Appendix F requirements
Combustor operating parameters (charge rate; secondary chamber temperature)
Wet scrubber operating parameters (exit temperature; scrubber liquid pH; scrubber liquid flow rate; energy input)

Testing:

- A. Initial and annual/skip tests for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; quarterly EPA Method 9 opacity tests
- B. Only initial tests for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; annual inspections; quarterly EPA Method 9 opacity tests

Option 2D (Exceedances) :

Monitoring:

CO/O₂ "Process Monitoring System" without extensive performance specification and correlation tests
Combustor operating parameters (charge rate; secondary chamber temperature)
Wet scrubber operating parameters (exit temperature; scrubber liquid pH; scrubber liquid flow rate; energy input)

Testing:

- A. Initial and annual/skip tests for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; quarterly EPA Method 9 opacity tests
- B. Only initial tests for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; annual inspections; quarterly EPA Method 9 opacity tests

Option 3 (Exceedances) :

Monitoring:

Combustor operating parameters (charge rate; secondary chamber temperature)
Wet scrubber operating parameters (exit temperature; scrubber liquid pH; scrubber liquid flow rate; energy input)

Testing:

- A. Initial and annual/skip tests for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; quarterly EPA Method 9 opacity tests
- B. Only initial tests for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; quarterly inspections; quarterly EPA Method 9 opacity tests

Option 4A (Continuous Compliance):

Monitoring:

No CEMS

Parameter or Predictive Monitoring System (i.e., redundant measurements of combustor operating parameters)

Testing:

- A. Initial and annual/skip tests for PM, CO, and HCl; only initial tests for CDD/CDF, Pb, Cd, Hg, and opacity; quarterly EPA Method 9 opacity tests
- B. Only initial tests for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; quarterly inspections; quarterly EPA Method 9 opacity tests

Option 4B (Exceedances):

Monitoring:

No CEMS

Combustor operating parameters (charge rate; secondary chamber temperature)

Wet scrubber operating parameters (exit temperature; scrubber liquid pH; scrubber liquid flow rate; energy input)

Testing:

- A. Initial and annual/skip tests for PM, CO, and HCl; only initial tests for CDD/CDF, Pb, Cd, Hg, and opacity; quarterly EPA Method 9 opacity tests
- B. Only initial tests for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; quarterly inspections; quarterly EPA Method 9 opacity tests

DRY SCRUBBERS

Option 1A (Continuous Compliance):

Monitoring:

CO/O₂ CEMS with Appendix F requirements
Opacity monitor without Appendix F requirements
HCl CEMS with Appendix F requirements
Combustor operating parameters (charge rate; secondary chamber temperature)
Dry scrubber operating parameters (inlet temperature to PM control device; carbon flow rate)

Testing:

- A. Initial and annual/skip tests for PM, CDD/CDF, Pb, Cd, Hg, and opacity
- B. Only initial tests for PM, CDD/CDF, Pb, Cd, Hg, and opacity; annual inspections

Option 1B (Continuous Compliance)

Monitoring:

CO/O₂ CEMS with Appendix F requirements
Opacity monitor without Appendix F requirements
Combustor operating parameters (charge rate; secondary chamber temperature)
Dry scrubber operating parameters (inlet temperature to PM control device; lime flow rate; carbon flow rate)

Testing:

- A. Initial and annual/skip tests for PM, CDD/CDF, HCl, Pb, Cd, Hg, and opacity
- B. Only initial tests for PM, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; annual inspections

Option 1C (Continuous Compliance):

Monitoring:

CO/O₂ CEMS with Appendix F requirements
Combustor operating parameters (charge rate; secondary chamber temperature)
Dry scrubber operating parameters (inlet temperature to PM control device; lime flow rate; carbon flow rate)

Testing:

- A. Initial and annual/skip tests for PM, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; quarterly EPA Method 9 opacity tests
- B. Only initial tests for PM, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; annual inspections; quarterly EPA Method 9 opacity tests

Option 1D (Continuous Compliance):

Monitoring:

CO/O₂ "Process Monitoring System" with extensive performance specification tests and correlation testing
Combustor operating parameters (charge rate; secondary chamber temperature)

Dry scrubber operating parameters (inlet temperature to PM control device; lime flow rate; carbon flow rate)

Testing:

- A. Initial and annual/skip tests for PM, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; quarterly EPA Method 9 opacity tests
- B. Only initial tests for PM, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; annual inspections; quarterly EPA Method 9 opacity tests

Option 2A (Exceedances):

Monitoring:

CO/O₂ CEMS without Appendix F requirements
Opacity monitor without Appendix F requirements
HCl CEMS without Appendix F requirements
Combustor operating parameters (charge rate; secondary chamber temperature)
Dry scrubber operating parameters (inlet temperature to PM control device; carbon flow rate)

Testing:

- A. Initial and annual/skip tests for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, and opacity
- B. Only initial tests for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; annual inspections

Option 2B (Exceedances):

Monitoring:

CO/O₂ CEMS without Appendix F requirements
Opacity monitor without Appendix F requirements
Combustor operating parameters (charge rate; secondary chamber temperature)
Dry scrubber operating parameters (inlet temperature to PM control device; lime flow rate; carbon flow rate)

Testing:

- A. Initial and annual/skip tests for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, and opacity
- B. Only initial tests for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; annual inspections

Option 2C (Exceedances) :

Monitoring:

CO/O₂ CEMS without Appendix F requirements
Combustor operating parameters (charge rate; secondary chamber temperature)
Dry scrubber operating parameters (inlet temperature to PM control device; lime flow rate; carbon flow rate)

Testing:

- A. Initial and annual/skip tests for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; quarterly EPA Method 9 opacity tests
- B. Only initial tests for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; annual inspections; quarterly EPA Method 9 opacity tests

Option 2D (Exceedances) :

Monitoring:

CO/O₂ "Process Monitoring System" without extensive performance specification and correlation tests
Combustor operating parameters (charge rate; secondary chamber temperature)
Dry scrubber operating parameters (inlet temperature to PM control device; lime flow rate; carbon flow rate)

Testing:

- A. Initial and annual/skip tests for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; quarterly EPA Method 9 opacity tests
- B. Only initial tests for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; annual inspections; quarterly EPA Method 9 opacity tests

Option 3 (Exceedances) :

Monitoring:

Opacity monitor without Appendix F requirements
Combustor operating parameters (charge rate; secondary chamber temperature)
Dry scrubber operating parameters (inlet temperature to PM control device; lime flow rate; carbon flow rate)

Testing:

- A. Initial and annual/skip tests for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, and opacity
- B. Only initial tests for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; quarterly inspections

Option 4A (Continuous Compliance) :

Monitoring:

No CEMS

Parameter or Predictive Monitoring System (i.e., redundant measurements of combustor operating parameters)

Testing:

- A. Initial and annual/skip tests for PM, CO, and HCl; only initial tests for CDD/CDF, Pb, Cd, Hg, and opacity; quarterly EPA Method 9 opacity tests
- B. Only initial tests for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; quarterly inspections; quarterly EPA Method 9 opacity tests

Option 4B (Exceedances) :

Monitoring:

No CEMS

Combustor operating parameters (charge rate; secondary chamber temperature)

Dry scrubber operating parameters (inlet temperature to PM control device; lime flow rate; carbon flow rate)

Testing:

- A. Initial and annual/skip tests for PM, CO, and HCl; only initial tests for CDD/CDF, Pb, Cd, Hg, and opacity; quarterly EPA Method 9 opacity tests
- B. Only initial tests for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; quarterly inspections; quarterly EPA Method 9 opacity tests

WET/DRY SCRUBBER COMBINATIONS

Option 1A (Continuous Compliance):

Monitoring:

CO/O₂ CEMS with Appendix F requirements

HCl CEMS with Appendix F requirements

Combustor operating parameters (charge rate; secondary chamber temperature)

Wet/dry scrubber combination operating parameters (exit temperature; inlet temperature to PM control device; scrubber liquid flow rate; energy input; carbon flow rate)

Testing:

A. Initial and annual/skip tests for PM, CDD/CDF, Pb, Cd, Hg, and opacity; quarterly EPA Method 9 opacity tests

B. Only initial tests for PM, CDD/CDF, Pb, Cd, Hg, and opacity; annual inspections; quarterly EPA Method 9 opacity tests

Option 1B (Continuous Compliance)

Monitoring:

CO/O₂ CEMS with Appendix F requirements

Combustor operating parameters (charge rate; secondary chamber temperature)

Wet/dry scrubber combination operating parameters (exit temperature; inlet temperature to PM control device; scrubber liquid pH; scrubber liquid flow rate; energy input; lime flow rate; carbon flow rate)

Testing:

A. Initial and annual/skip tests for PM, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; quarterly EPA Method 9 opacity tests

B. Only initial tests for PM, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; annual inspections; quarterly EPA Method 9 opacity tests

Option 1C (Continuous Compliance):

Monitoring:

CO/O₂ CEMS with Appendix F requirements

Combustor operating parameters (charge rate; secondary chamber temperature)

Wet/dry scrubber combination operating parameters (exit temperature; inlet temperature to PM control device; scrubber liquid pH; scrubber liquid flow rate; energy input; lime flow rate; carbon flow rate)

Testing:

- A. Initial and annual/skip tests for PM, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; quarterly EPA Method 9 opacity tests
- B. Only initial tests for PM, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; annual inspections; quarterly EPA Method 9 opacity tests

Option 1D (Continuous Compliance):

Monitoring:

CO/O₂ "Process Monitoring System" with extensive performance specification tests and correlation testing
Combustor operating parameters (charge rate; secondary chamber temperature)
Wet/dry scrubber combination operating parameters (exit temperature; inlet temperature to PM control device; scrubber liquid pH; scrubber liquid flow rate; energy input; lime flow rate; carbon flow rate)

Testing:

- A. Initial and annual/skip tests for PM, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; quarterly EPA Method 9 opacity tests
- B. Only initial tests for PM, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; annual inspections; quarterly EPA Method 9 opacity tests

Option 2A (Exceedances):

Monitoring:

CO/O₂ CEMS without Appendix F requirements
HCl CEMS without Appendix F requirements
Combustor operating parameters (charge rate; secondary chamber temperature)
Wet/dry scrubber combination operating parameters (exit temperature; inlet temperature to PM control device; scrubber liquid flow rate; energy input; carbon flow rate)

Testing:

- A. Initial and annual/skip tests for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; quarterly EPA Method 9 opacity tests
- B. Only initial tests for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; annual inspections; quarterly EPA Method 9 opacity tests

Option 2B (Exceedances):

Monitoring:

CO/O₂ CEMS without Appendix F requirements

Combustor operating parameters (charge rate; secondary chamber temperature)
Wet/dry scrubber combination operating parameters (exit temperature; inlet temperature to PM control device; scrubber liquid pH; scrubber liquid flow rate; energy input; lime flow rate; carbon flow rate)

Testing:

- A. Initial and annual/skip tests for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; quarterly EPA Method 9 opacity tests
- B. Only initial tests for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; annual inspections; quarterly EPA Method 9 opacity tests

Option 2C (Exceedances):

Monitoring:

CO/O₂ CEMS without Appendix F requirements
Combustor operating parameters (charge rate; secondary chamber temperature)
Wet/dry scrubber combination operating parameters (exit temperature; inlet temperature to PM control device; scrubber liquid pH; scrubber liquid flow rate; energy input; lime flow rate; carbon flow rate)

Testing:

- A. Initial and annual/skip tests for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; quarterly EPA Method 9 opacity tests
- B. Only initial tests for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; annual inspections; quarterly EPA Method 9 opacity tests

Option 2D (Exceedances):

Monitoring:

CO/O₂ "Process Monitoring System" without extensive performance specification and correlation tests
Combustor operating parameters (charge rate; secondary chamber temperature)
Wet/dry scrubber combination operating parameters (exit temperature; inlet temperature to PM control device; scrubber liquid pH; scrubber liquid flow rate; energy input; lime flow rate; carbon flow rate)

Testing:

- A. Initial and annual/skip tests for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; quarterly EPA Method 9 opacity tests
- B. Only initial tests for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; annual inspections; quarterly EPA Method 9 opacity tests

Option 3 (Exceedances) :

Monitoring:

Combustor operating parameters (charge rate; secondary chamber temperature)

Wet/dry scrubber combination operating parameters (exit temperature; inlet temperature to PM control device; scrubber liquid pH; scrubber liquid flow rate; energy input; lime flow rate; carbon flow rate)

Testing:

- A. Initial and annual/skip tests for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; quarterly EPA Method 9 opacity tests
- B. Only initial tests for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; quarterly inspections; quarterly EPA Method 9 opacity tests

Option 4A (Continuous Compliance) :

Monitoring:

No CEMS

Parameter or Predictive Monitoring System (i.e., redundant measurements of combustor operating parameters)

Testing:

- A. Initial and annual/skip tests for PM, CO, and HCl; only initial tests for CDD/CDF, Pb, Cd, Hg, and opacity; quarterly EPA Method 9 opacity tests
- B. Only initial tests for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; quarterly inspections; quarterly EPA Method 9 opacity tests

Option 4B (Exceedances) :

Monitoring:

No CEMS

Combustor operating parameters (charge rate; secondary chamber temperature)

Wet/dry scrubber combination operating parameters (exit temperature; inlet temperature to PM control device; scrubber liquid pH; scrubber liquid flow rate; energy input; lime flow rate; carbon flow rate)

Testing:

- A. Initial and annual/skip tests for PM, CO, and HCl; only initial tests for CDD/CDF, Pb, Cd, Hg, and opacity; quarterly EPA Method 9 opacity tests
- B. Only initial tests for PM, CO, CDD/CDF, HCl, Pb, Cd, Hg, and opacity; quarterly inspections; quarterly EPA Method 9 opacity tests